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THE OPERATIONS OF SURGERY

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THE

OPERATIONS OF SURGERY

INTENDED ESPECIALLY FOR THE USE OF
THOSE RECENTLY APPOINTED
ON A HOSPITAL STAFF

AND FOR

THOSE PREPARING FOR THE HIGHER EXAMINATIONS

BY

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SURGEON IN CHARGE OF THE THROAT DEPARTMENT, GUY'S HOSPITAL

FOURTH EDITION

WITH FIVE HUNDRED AND FIFTY ILLUSTRATIONS

VOL. I

PHILADELPHIA
P. BLAKISTON'S SON & CO.
1012 WALNUT STREET
1902

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PARDON AND SONS, PRINTERS
WINE OFFICE COURT, FLEET STREET
LONDON

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PREFACE TO THE FOURTH EDITION.

THIS book, of which the first edition appeared in 1888, the second in 1891, and the third in 1897, was the outcome of a strong belief, which I have held for many years, that a work on Operative Surgery which aimed at being more comprehensive in scope and fuller in detail than those already published, would be of service to many who had recently been elected to hospital appointments, and to those who were working for the higher examinations. For the delay connected with the appearance of the present edition, I, alone, am responsible. It has arisen partly from other calls on my time, but chiefly from the time and trouble which are needed in an attempt to bring a book like this up to date, and from the dissatisfaction which increases, with increasing experience, at each result.

Tardy as has been the appearance of this edition, it has only been made possible through the help of Mr. F. J. Steward. I am very grateful to him for taking more than half the work off my hands, my share of this edition coming to an end at p. 684, Vol. I., with the close of the section on "Removal of the Breast." It is right that I should add that I am also responsible for nearly all the new illustrations.

I would take this opportunity of also expressing my gratitude both to the publishers, Messrs. Churchill, and the printers, Messrs. Pardon and Sons, for the forbearance which has been so patiently shown to me.

Of the 199 illustrations in the first edition the majority were made by Mr. C. W. Hogarth. For most of those which have since been added I am indebted, through M. Masson, the publisher, to Prof. Farabeuf's *Précis de Manuel Opératoire*; through Herren Lipsius and Tischer, of Kiel, to Prof. Esmarch's and Dr. Kowalzig's *Chirurgische Technik*; and to the *Abdominal Surgery* of Mr. Greig Smith and Mr. J. Swain. My knowledge of the second book is entirely owing to Mr. Lockwood. I should also acknowledge here my indebtedness to the late Sir W. Mac Cormac, the late Mr. Anderson, and to Mr. Jessett and Mr. F. T. Paul for their permission to make use of blocks and illustrations. I have, also, gratefully availed myself of the permission of Mr. Heath—a permission the more acceptable and valued because unsought—to make use of any of the illustrations in his well-known *Course of Operative Surgery*. These illustrations, by M. Léveillé, of Paris, have long been familiar to operating surgeons.

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PART I.

OPERATIONS ON THE UPPER EXTREMITY.

CHAPTER I.

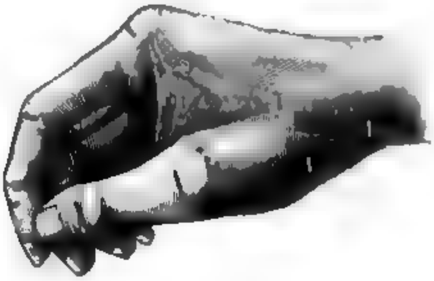
OPERATIONS ON THE HAND.

AMPUTATION OF THE FINGERS.

Practical Anatomical Points.—I. POSITION OF THE JOINTS (Fig. 1).—This has to be remembered—(α) in front, (β) behind.

(α) *In front.*—Three sets of creases correspond here, though not exactly to the joints. Of these, the lowest crease is just above the joint; the middle is opposite to the inter-phalangeal joint; the highest, nearly $\frac{3}{4}$ inch below the metacarpo-phalangeal joint.

FIG. 1.



(Farabeuf)

(β) *Behind.*—It is to be remembered here (1) that in each case it is the upper bone which forms the prominence—viz., the knuckle is formed by the head of the metacarpal bone, the inter-phalangeal prominence by the head of the first phalanx, and the distal one by the head of the second; (2) that the joint in each case lies below the prominence, the distal joint being $\frac{1}{12}$ inch, the inter-phalangeal $\frac{1}{8}$ inch, and the metacarpo-phalangeal joint about $\frac{1}{3}$ inch below.*

---

* The terms "above" and "below" mean nearer to and farther from the trunk.

II. Shape of the Joints.—In the distal and the inter-phalangeal the joint is concave from side to side, and presents a concavity towards the tips: in the metacarpo-phalangeal joint, on the other hand, the convexity is towards the finger-tips.

III. The Theca.—This fibrous tunnel running down to the bases of the distal phalanges and upwards to the palm gapes widely after section. From the readiness with which the tendons conduct sepsis into the forearm itself, care should be taken to keep even such a small amputation as that of a finger strictly sterile, and, in amputating through damaged parts, the flaps should not be too closely united with sutures.

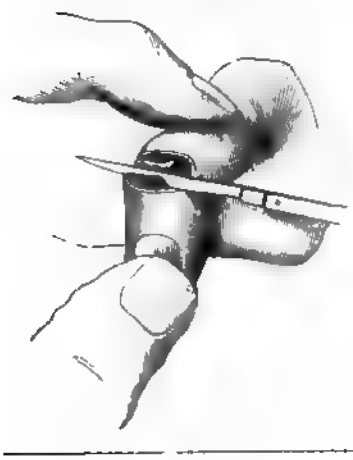
Operations for Amputation of the Fingers.—As one fixed method is rarely available, and as the rule here to remove as little as possible is unalterable, several should be practised, including among them the following four, of which the first two are the best—viz.:

1. Long palmar flap (Figs. 2, 5 and 6).
2. Long palmar and short dorsal flap (Fig. 7).
3. Two lateral flaps (Figs. 4 and 7). These may be (*α*) equal, (*β*) unequal.
4. One long lateral flap.
5. Two equal antero-posterior flaps.*

Of these, the palmar flap is usually the one made use of. Though, as the hands are by far most frequently placed in the prone position, a dorsal flap falls more easily into place, and gives a more concealed scar, a palmar flap has the greater advantages of a scar which is not pressed upon when anything is held in the hand, of possessing finer sensitiveness in touch and better nutrition; furthermore, this flap is available even in the last phalanx, where, from the presence of the nail, a dorsal flap is not obtainable (Fig. 2).

Amputation of a Distal Phalanx by a Palmar Flap (Fig. 2).—**First Method.**—The hand being pronated, a strip of sterilised gauze wound round the phalanx so as to give a firm grip,† and the adjacent fingers well flexed, the surgeon, having placed his left forefinger just below and behind the joint, and flexed the phalanx strongly with his thumb (a step not always easy with infiltrated tissues), cuts,‡ with a slightly semilunar sweep, and drawing the blade from heel to toe, straight into the joint. To effect this neatly, the convexity of the sweep should pass $\frac{1}{12}$ inch below the prominence or angle produced by flexion, the sweep being made by laying on the whole edge of the knife, while with the point, as this incision begins and ends, the lateral ligaments are partly cut. The joint being thus freely opened, the knife is insinu-

Fig. 2.



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* These will produce a stump with an exposed scar.

† In the drawing this is left out for the sake of distinctness.

‡ The knife in all these finger amputations should be narrow, short, and slender, yet strong (Figs. 2 and 6).

ated behind the base of the phalanx (a step which is facilitated by depressing and pulling on the phalanx), and then, being kept close to, and parallel with, the bone, cuts, with a steady sawing movement, a flap well rounded at its extremity, about two-thirds in length of the pulp of the finger.*

Second Method.—The hand being supinated, the finger to be operated on extended, and the others flexed out of the way, a palmar flap is cut by transfixion, the knife being entered just below the palmar crease, the joint being then opened from the dorsum as before, and the phalanx lastly disarticulated. If transfixion be made use of, the following comment of Mr. Treves (*Oper. Surg.*, vol. i. p. 327) must be remembered: "In no operation upon the fingers is it well to cut the flaps by transfixion. In cutting a palmar flap by this means there is danger of slitting up the digital arteries. The flap, moreover, is apt to be pointed and scanty, and to contain fragments of tendon."

Third Method.—If the surgeon has no narrow knife by him, he may modify the last method by cutting his palmar flap first, but from without inwards; he then opens the joint from the dorsum, and disarticulates.

As a rule, no vessels require ligature. Any tendon that is jagged should be cut square.

Difficulties and Mistakes in Amputation of a Distal Phalanx.—(1) The flap may, of course, be made too short; it is often made too pointed. I would take this opportunity of reminding my younger readers that as the long bones of the hand are large in relation to their soft parts, the flap or flaps should always be cut sufficiently long. The student must in this, his first amputation, fix upon his mind a rule which must be followed in all amputations, large or small—to measure with the eye whether the flap or flaps will be sufficient, just before the flap is finally cut. (2) If the phalanx be not sufficiently flexed, or if the site of the joint has not first been marked out with the nail, the latter will not be readily opened. It is very common for students, forgetting that in the case of each joint this lies below the corresponding prominence (Fig. 1), to cut above the level of the joint here, their knife sawing against the neck or head of the second phalanx. (3) It is often difficult to pass the knife readily behind the base of the phalanx, especially in cases where the blade is too broad, or where, as in well-developed hands, the base of the phalanx is strongly tuberculated. (4) If there be any hitch in passing the knife behind the phalanx, the outline of the flap is very likely to be jagged, and to cause sloughing.

Amputation of the Second Phalanx (Figs. 4 and 5).—This, as a rule, should be performed through the phalanx, and, whenever this is possible, beyond its centre, so as to leave the upper half or third of the phalanx, and thus ensure some attachment of the flexor sublimis being preserved.

While the rule not to amputate a finger at the joint between the first and second phalanges, and *à fortiori* through the first phalanx, is a sound one, as there is a risk of leaving a stump stiff and incapable of flexion, there is no doubt whatever that at times the above amputation has been followed by the flexor tendon taking on a fresh and sufficiently firm adhesion, and so leaving a longer and, withal, a mobile stump.

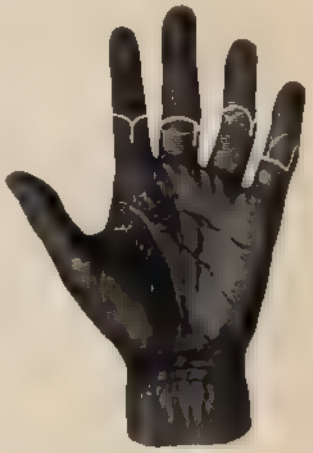
---

* If the flap is insufficient, the head of the second phalanx must be removed. In this and in other amputations in the hand, owing to the soft parts cut through being often infiltrated and fixed, the flaps are easily made too short, from the desire of the surgeon to leave as much as possible.

In the following special cases the whole or part of the first phalanx may be left, and in all of them the severed flexor tendons should be carefully stitched with sterilised silk to the cut theca and periosteum, or into the flaps before these are adjusted. Another plan is to suture together the flexor and extensor tendons (cut square) over the end of the bone (Waring).

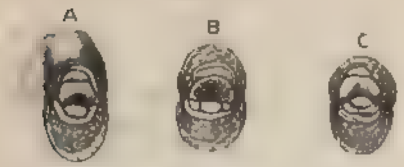
(1) In the case of the index finger the proximal phalanx will be a useful opponent to the thumb as in holding a pen. (2) In the case of the little finger, leaving the proximal phalanx will give greater symmetry to the hand when this is flexed, and it should accordingly be left, if the patient desire it. (3) In amputation of all the fingers, the proximal phalanx of one should, if possible, always be left to oppose to the thumb. (4) Where a patient insists on having the proximal phalanx left, after the risk of stiffness has been explained to him. The more care is taken to fix the severed flexors to the theca or extensors, the more quickly the stump heals, and the younger the patient, the greater will be the movement gained.*

FIG. 4



Different methods for partial removal of the fingers. In the index, two rounded lateral flaps, in the middle finger, two square dorsal and palmar; in the case of the ring finger, two rounded flaps, dorsal and palmar, and in the little finger, a single dorsal flap, are shown (Farabeuf.)

FIG. 3



A. Flaps after amputation of terminal phalanx. B. Flaps after amputation through second phalanx. C. Amputation of second phalanx (Heath). In each case anteroposterior flaps have been made. In B the flexor tendon, and in C both flexor and extensor tendons, should be sutured as directed above.

Amputation through, or Disarticulation of the Middle Phalanx.

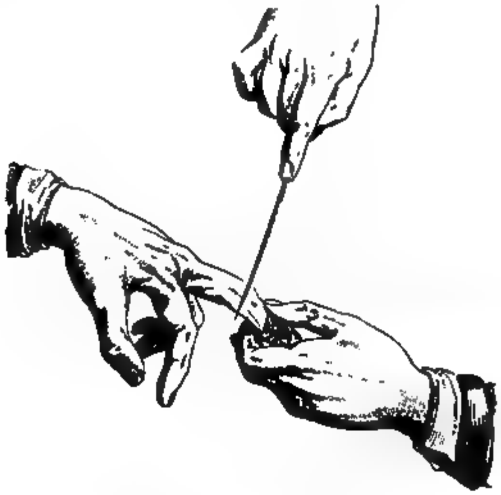
(1) **By a Long Palmar or Dorsal Flap** (Figs. 5 and 6), **or by Dorso-palmar Flaps,** the flaps being equal, or the palmar one the longer (Figs. 4 and 7).

---

* Dr. Tiffany, of Baltimore (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 826), says that he has been in the habit "for a number of years" of passing the stitches which unite the skin through the tendons and their sheaths in amputation at the joint between the first and second phalanges. "I have never failed, as far as I can remember, to secure quite as good movement as if Nature had originally made an attachment there for these tendons."

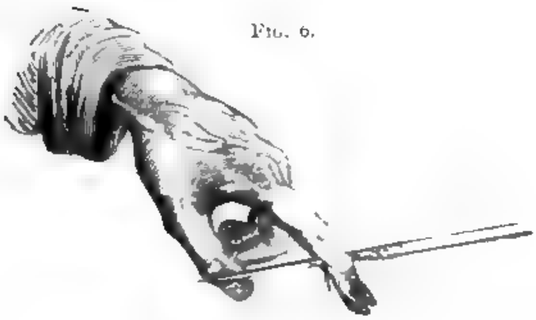
By Dorso-palmar Flaps.—The surgeon, having marked with his left forefinger and thumb* the spot where he intends to divide the bone, cuts between these points a short, well-rounded dorsal flap of skin; he then sends his knife across below the bone, making it enter and emerge at the base of the first flap, and cuts a palmar flap about $\frac{3}{8}$ inch in length, and not pointed. The flaps are then retracted, the bone cleared with a circular sweep of the knife, and divided in the manner given below.

Fig. 5.



Amputation through the inter-phalangeal joint by a long palmar flap, the joint being opened first. (Fergusson.)

Fig. 6.



Amputation through the second phalanx by a long palmar flap, this being made first by transfixion. (Fergusson.)

By Lateral Flaps (Figs. 4 and 7).—The site where the bone is to be sawn having been marked by the left forefinger and thumb placed on the dorsal and palmar aspects of the finger at this level, the surgeon, looking over the finger, enters his knife in the centre of the palmar aspect, and carries it, cutting an oval flap, about $\frac{1}{2}$ inch in length, to a corresponding point on the centre of the dorsum, and then from this point down again over the side of the finger nearest to him, to the point where the knife was first entered. The flaps being dissected up as thick as possible, and the remaining soft parts severed with a circular sweep, the bone is divided with saw or bone-forceps. If necessary, one flap can be

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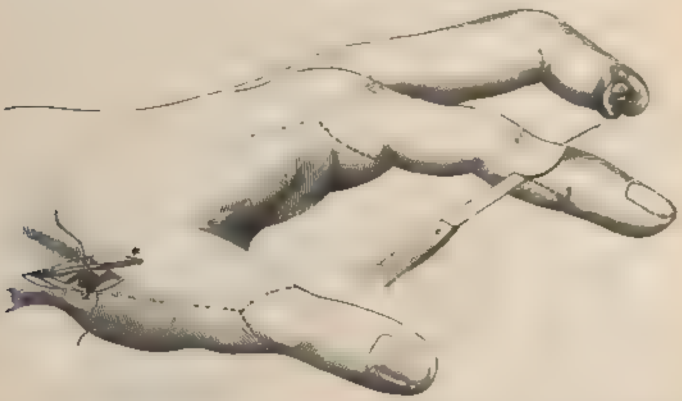
* These are left out of the drawings for the sake of distinctness.

FIG. 7



In the second finger, amputation through the second phalanx by lateral flaps is shown. The bone has been divided below the insertion of the flexor sublimis; if there were any doubt about this, the tendon would be stitched to the theca and flaps, as advised at p. 4. In the index finger, amputation through the second phalanx by short dorsal and long palmar flaps is figured. The left finger and thumb of the surgeon, which would mark the base of the flaps, are left out for the sake of distinctness. The flaps for amputation of the index finger at the metacarpo-phalangeal joint are also shown, the straight part of the incision being placed rather to the radial side of the head of the metacarpal bone. The scar would be better hidden if the incision had been placed on the ulnar side (p. 8).

In the thumb, the flaps for amputation at the carpo-metacarpal joint are indicated. The two * * show where the radial artery may be wounded, near the joint, and in the interosseous space, in this amputation (p. 11).

Ligature of the radial artery at the back of the wrist is also represented. The radial vein crosses the wound from angle to angle. The artery, with the ligature under it, is shown between the extensor ossis metacarpi and extensor primi internodii in the lower angle, and the extensor secundi internodii in the upper angle of the wound (p. 63).

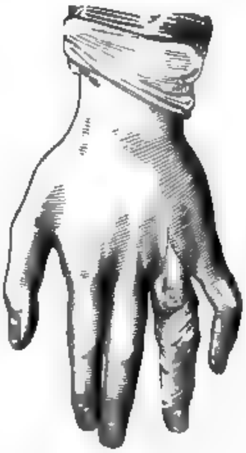
cut longer than the other. In using the bone-forceps the concave surface is always to be turned away from the trunk; if this precaution is taken, and the bones severed quickly, the section will be clean, and not crushed. But a fine metacarpal or a small Butcher's saw is the safer instrument.

Amputation of a Finger, e.g., Second or Third, at the Metacarpo-phalangeal Joint (Figs. 7, 8, 9 and 10). This, the commonest amputation in the hand, should be often practised. It is usually performed by the modified oval method, the *en raquette* of Malgaigne. Lateral flaps I consider better. Other methods, to be used according to the condition of the soft parts, are shown below (Fig. 10).

The hand having been pronated, the radial and ulnar arteries com-anded by an Esmarch's bandage or the fingers of an assistant above the st, some sterilised gauze wrapped round the damaged finger, and the cent [illegible] lexed out of the way or held aside with strips of sterilised gauze, the point of the knife is entered ¾ inch above the head of the metacarpal bone, sunk down to the bone itself, and then carried down in the middle line till it gets well on to the base of the phalanx; then, diverging to one side, the knife is carried obliquely below the web* across the palmar aspect of the first phalanx below the palm, and then around the other side of the phalanx (also below the web) so as to join the straight part of the incision which lies over the head of the metacarpal bone.

Lateral Flaps.—In practice, especially in the country, where an anæsthetic is not always easily available, it is much preferable, because quicker, to make two separate incisions, each beginning ¾ inch above the head of the metacarpal bone, and meeting again on the centre of the base of the palmar aspect of the first phalanx, well below the palm, instead of carrying the knife continuously round the finger. This method is not only quicker,† but it does not leave, as in the first method, a small tongue of tissue on the palmar aspect, which is a little difficult to adjust satisfactorily, and behind which discharges may collect.

FIG. 8.



Incisions for amputation at the metacarpo-phalangeal joint If the metacarpal bone requires removal as well, the apex of the incision would be prolonged upwards. (Fergusson.)

In either case the knife should be used boldly, the extensor tendon severed in the first incision over the head of the metacarpal bone, and the soft parts at the sides cut to the bone. Then, one lip of cut tissue being taken up with the finger and thumb, the flaps are dissected up as thick as possible. tendons cut clean and square, the lateral ligaments severed, and the joint opened by recollection of its site well below the projecting knuckle (p. 1, Fig. 1). Disarticulation will be facilitated by twisting the finger, first to one side, and then to the other, so as to render tight the parts which remain to be cut.

Where strength has to be considered rather than appearance, the head of the metacarpal bone should be left, whatever be the rank in life of the patient, as the transverse ligament is thus less interfered with, the hand less weakened, and the palm not opened up. But where appearance is the most important point, and the mutilation is to be hidden as much as possible by the approximation of the fingers, the head of the bone should be removed by a narrow-bladed saw or by bone-forceps‡ (Fig. 9). In either case the section should be made obliquely from above downwards and from behind forwards, so as to remove more on the dorsal than the palmar aspect. In such cases, after a little practice, it is not necessary to perform disarticulation, the metacarpal bone being severed after the flaps have been dissected upwards to the proper level. Here, too, care must be scrupulously taken not to interfere with the tissues in the palm.

---

* Cutting into the web will lead to much more hæmorrhage, too short flaps unless the head of the bone is removed, and increase of pain in healing.

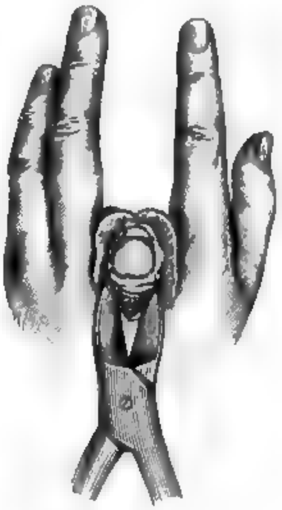
† Because it avoids the hitch usually met with in carrying the knife around the base of one finger between two others.

‡ With the precautions given at p. 6. The saw, avoiding splint [illegible] preferable.

After removal of the finger and the Esmarch's bandage, one or more digital vessels will require ligature, lying rather deeply opposite the web of the finger.*

In the case of the index (Figs. 7 and 10) or little finger, the straight part of the oval incision should be placed to the ulnar side of each metacarpal bone, rather than in the dorsal mid-line, as, in the former case, the line of incision will be better concealed between the thumb and second finger, and in the latter, be less visible in the ordinary pronated position of the hand. In these cases the saw or bone-forceps should be applied obliquely from without inwards and from within outwards respectively, so as to leave no projecting bone on the radial or ulnar aspect of the hand, and, in the former case, to allow of the thumb being readily approximated to the adjacent finger.

FIG. 9.



Amputation of the middle finger by lateral flaps (Heath). The neck of the bone should be more fully cleaned, the tendons separated, and the bite of the forceps pressed more securely round the neck of the bone.

It may be worth while to add one hint with regard to the after-treatment, and that is, not to bandage the adjacent fingers too closely or too long together, otherwise a tendency to cross at their points will be noticed later on.

Disarticulation by a Circular Incision with a Straight One on the Dorsum (Fig. 10).—This method, a modification of the one *en raquette*, is preferred by Farabeuf as simpler and sacrificing less skin. The hand being completely supinated, and the other fingers bent out of the way, the surgeon cuts across the root of the finger in the digito-palmar fold, going down to the bone, and encroaching as far as possible on the sides of the finger. The hand being pronated, the ends of the circular incision are prolonged up to the middle line of the dorsal aspect of the finger, where a straight cut, beginning a little above the level of the joint, is drawn down to and perpendicular to the first. By this means, two right-angled flaps are marked out. These are raised, and the bone disarticulated, by the steps already given.

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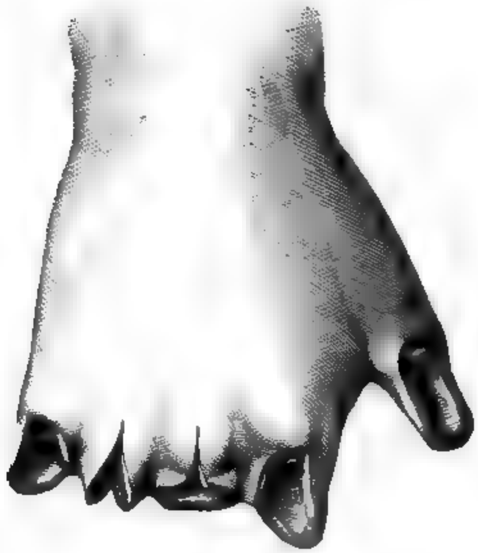
* Care should be taken to secure these vessels, especially where they are enlarged in any inflammatory condition, otherwise profuse bleeding may take place a few hours after the operation.

FIG. 10.



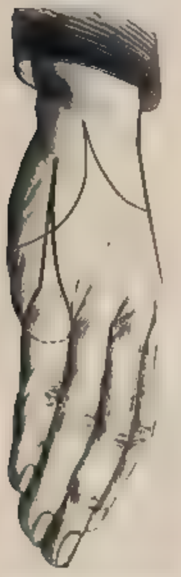
Different methods of amputating the thumb and fingers at their metacarpo-phalangeal joints. In the case of the thumb a long palmar flap has been made; in the index a palmar and external flap; in the middle finger a circular incision and a straight dorsal cut (a modification of the method *en raquette*) have been employed; the ring finger has been removed by two lateral flaps, and the little one by an internal and palmar flap. (Farabeuf.)

Amputation by a Single Flap.—Where, owing to the state of the soft parts, this method is required, Fig. 10 shows how it may be employed.

Amputation of a Finger, together with Removal (complete or partial) of its Metacarpal Bone.—This operation is easily performed by a modification of the method *en raquette* or that by lateral flaps just described. It is only needful to prolong the dorsal part of the former incision or the apex of the latter as far as the carpo-metacarpal joint. Disarticulation, when the parts are much swollen, will be safely performed here by carefully prolonging back the dorsal incision in a wound kept bloodless till the joint is felt and seen, suitably manipulating the finger so as to put the structures attached to the metacarpal bone on the stretch, remembering the insertion of tendons into some of these bones, and not sinking the knife into the palm for fear of wounding the palmar synovial sac or the deep palmar arch.

In the case of the little finger the ulnar border should be chosen for the incision, or, if the dorsal tissues are much damaged, a palmar and internal flap may be made. In clearing the metacarpal bone the knife-point must be kept very close to the bone. If only a portion of the bone needs removal, this should be divided with a saw and not bone-forceps. Farabeuf gives the very practical hint that primary union should be secured by the flaps meeting readily. Otherwise the contraction of the scar will drag upon the next surviving finger, and cause it to stick out from its fellows in a very ugly fashion.

FIG. 11.



Removal of little finger and its metacarpal bone by the oval method. (Care has been taken not to cut into the web. Amputation of the wrist by antero-posterior flaps is also shown. Heath.)

Amputation of Two or Three Contiguous Fingers.—When (a very rare contingency) two or more fingers require removal at the same level—*i.e.*, through their metacarpo-phalangeal joints, or higher up the modified racquet or lateral flaps may again be employed, the apex of the dorsal incision starting between the fingers when two, and over the central metacarpal bone when three fingers have to be removed.

AMPUTATION OF THE THUMB.

Amputation of Phalanges of Thumb.—Very little need be said about this operation, as it is very rarely performed. Owing to its numerous muscles, the thumb is extremely mobile, and thus escapes injury. Thanks to its abundant vascular supply, trimming of the soft parts after an injury will generally leave more of the thumb to oppose to the fingers than any set operation.

In cases of necrosis after whitlow, I have twice removed both phalanges, the soft parts consolidating usefully[*] with the aid of the periosteum that was left. For further remarks on preserving the thumb, see Excision of the Thumb, p. 12.

Operation.—Amputation of the phalanges of the thumb may be performed, in the case of the distal one, by a long palmar flap, as in the case of a finger (Figs. 2, 5 and 10); in the case of the first phalanx, by antero-posterior, lateral, or a modification of the oval method. In any case the incisions should be carried well on to the phalanx to ensure sufficient flaps to cover the head of the metacarpal bone, together with the sesamoid bones, which should never be removed.

The line of the metacarpo-phalangeal joint is very nearly transverse, and lies just in front of the knuckle.

After amputation of, or through, the phalanges, the severed end of the long flexor should be carefully stitched into the angle of the flaps and to the extensor or into the theca and periosteum.

Amputation of the Thumb at the Carpo-metacarpal Joint (Figs. 7 and 12).

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[*] This is strongly indicated in those cases where it is especially important to leave the thumb long for holding a pen or delicate instrument.

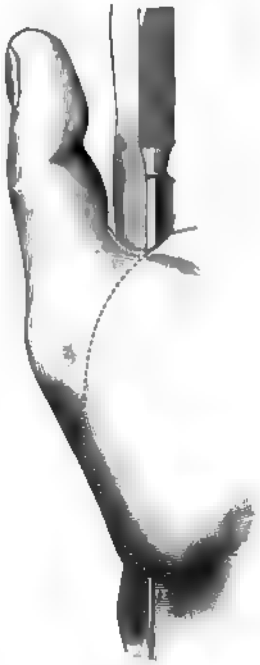
Indications.—This operation is rarely called for on the living subject.* Gunshot injuries, some growths of the phalanges and metacarpal bone (see below, p. 12), epithelioma of a scar, and melanotic sarcoma, occasionally call for it.

Operation.—The position of the joint between the trapezium and metacarpal bone, its shape, with two saddle-like articular surfaces fitting into each other "by reciprocal reception," and the position of the radial artery passing over the back of the styloid process just above this joint (Figs. 7 and 38), and again, when perforating the first interosseous space, lying close to the metacarpal bone, must be remembered.

The operation is usually performed **by the oval method** (Fig. 7).

An Esmarch's bandage having been applied above the wrist, the hand held midway between pronation and supination, and the thumb held over-extended so as to relax the parts, the surgeon enters the point of a strong narrow scalpel or bistoury just above the joint. This lies a full finger's-breadth below the tip of the styloid process. Its position can usually be made out by tracing up the metacarpal bone with one finger along its inner, and the thumb along its outer, margin, the thumb being alternately abducted and adducted. The knife, entering between the tendons of the extensor ossis and primi internodii, should avoid *la tabatière anatomique* (p. 63) and the radial artery. Where there is much swelling comparison must be made with the sound thumb. The incision is then carried along the dorsum of the bone as far as the base of the first phalanx, where it passes (in the case of the left thumb) obliquely to the ulnar side above the web, and then around the palmar aspect of the phalanx, along the radial side, to join the dorsal incision again. Taking up first one edge of the incision and then the other, the surgeon dissects up the soft parts from the bone, keeping the knife-point very close to this, especially on the inner side. The extensor tendons and the short muscles of the thumb being severed, the joint between the trapezium and metacarpal bone is felt for and opened, and the thumb removed, by putting the remaining tissues on the stretch by twisting the metacarpal bone in different directions.

FIG 12.



Amputation of the Thumb at the Carpo-metacarpal Joint by Transfixion (Fig. 12).—The hand being held as before, and the parts relaxed by slightly adducting the thumb, an incision is made (in the case of the left thumb) from the base of the metacarpal bone rather to its palmar aspect, along its dorsum, and then obliquely to the ulnar side of the base of the first phalanx: the knife, a long narrow bistoury, is then pushed from this point, at the junction of the web with the thumb, across the palmar aspect of the thumb, to the point where the incision started, over the carpo-metacarpal joint. By cutting outwards, along the line indicated in Fig. 12, a flap is formed of the tissues in the ball of the thumb, the knife being kept close to the bone at first, but used more lightly and kept more superficial afterwards, as it comes out through the skin over the sesamoid bones and base of the first phalanx, to avoid being locked here. This flap being held back, the metacarpal bone is dissected out by keeping the knife close to it, the joint opened, and the thumb removed as before.

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* It is not unfrequently used as an examination test.

On the right side, it is better to cut the palmar flap by transfixion first, making it enter and emerge just as above given. The blade of the knife is then drawn from the base of the first phalanx obliquely across the dorsum of the metacarpal bone, from one extremity of the transfixion incision to the other. The operation is then completed as before.

In practice, total removal of the thumb is one of the rarest amputations. Part of the metacarpal bone should always be left, if possible. Even if stiff, it will be most useful when the fingers are opposed to it. The long flexor should always be sutured as advised at p. 4.

PARTIAL EXCISION OF THE THUMB.

Removal of Phalanges.—Owing to the exceeding value of the thumb, a phalanx should always be preserved, if possible, not only in whitlow-necrosis, but in the case of the first or proximal phalanx when it is the seat of enchondroma. By this, not only is appearance saved by the lessened shortening, but the use of the long flexor, in particular, is preserved.

Mr. Royes Bell (*Lancet*, 1872, vol. ii. p. 846) published a case in which he excised the proximal phalanx in a woman, aged 19, for a huge enchondroma of sixteen years' growth, the joints being movable. The phalanx was excised by two semilunar incisions over the tumour, the knife kept close to the bone, and the joints opened. No tendons were cut. Eighteen months later the condition of the thumb was excellent, both for all general movements and for writing.

In 1897 I performed a like operation on a patient aged 33. The first phalanx of the right thumb was removed, by a single dorsal incision, for an enchondroma of twelve years' standing, and the base of the distal one resected for a similar, but much smaller, growth. The long flexor was stitched to the portion of the distal phalanx left. The thumb was put up in a perforated zinc splint. Healing was complete in three weeks; active and passive movements were then assiduously begun. When I last saw the patient, six months after the operation, the thumb was much shortened and also somewhat weaker than its fellow, but it was steadily gaining in strength and usefulness, and its movements were almost completely restored.

Removal of Metacarpal Bone.—This should always be excised, wherever possible, in preference to sacrificing a part of such incalculable value as the thumb.

Sir W. Fergusson (*Pract. Surg.*, p. 322), in speaking of this operation, says that he saw it once performed, and, though the member was far from strong, the patient could use a needle with tolerable facility afterwards, and he further remarks that the comparative shortness of the bone removed, and the firm cushion of soft parts that remains after its excision, will make the remaining part useful.

A straight incision, which reaches $\frac{1}{4}$ inch beyond each extremity of the bone, having been made along the dorsum, the tendons are drawn aside;

the distal end and joint are next cleared and opened, when the bone can be used as a lever whilst it is freed from the soft parts on the palmar aspect and then disarticulated. Removal of this, as with the other metacarpals, is sometimes facilitated by dividing the bone in the centre and removing it in two pieces. In young subjects the epiphysis, if healthy, should be left. If possible, the periosteum should always be preserved.

The radial artery must be remembered both on the ulnar side of the metacarpal bone and at the carpo-metacarpal joint (Figs. 7 and 38).

Excision of Metacarpo-phalangeal Joint.—This may be very occasionally required in those cases where a dislocation of the first phalanx cannot be reduced, either as a primary operation or, later on, in a young and healthy patient, to whom the stiffness is a serious drawback. Still rarer cases are those where the dislocation can be reduced but recurs at once.

An incision, 1½ inch long, on the radial side will leave least scar. When the joint is opened, any tight bands, whether of the lateral or the transverse fibres uniting the sesamoid bones, and corresponding to the glenoid ligament or the flexor brevis, are divided.* If more is required the soft parts are freely retracted, and the head and lower end of the metacarpal bone having been cleared by keeping the knife-point closely applied to them, sufficient is then removed *in situ* by a narrow saw, which is preferable to bone-forceps. Free resection of this bone will probably suffice, if sufficiently free; but if, owing to the amount of matting, or previous inflammation, there be additional risk of ankylosis, the base of the first phalanx should be removed as well. Care must be taken, before this is done, to detach carefully, as completely as possible, the tendons inserted into it, together with the periosteum. Passive movements should be begun a few days after, and persevered with until the cure is complete.

EXCISION OF THE FINGERS.

Only excision of joints need be alluded to here, as, save in the case of removal of the distal phalanx (or the last two in the case of the index) for necrosis, excision of a phalanx leaves a very useless finger.

Excision of an Inter-phalangeal or Metacarpo-phalangeal Joint.—This may be called for after a clean cut into the joint (circular saw, &c.); in the hope of saving one or more damaged fingers when several have required amputation after a machinery accident; in some cases of compound dislocation; in a few cases of disease—thus, in young subjects, in the case of the index finger, *e.g.*, where there is only one joint affected, and the mischief is limited to the articular surfaces and the bones themselves are sound. Excision of one of the above joints is best performed by an incision, 1½ inch long, to one side of the dorsum of the joint. It is always a difficult operation owing to the close connection of the tendons with the capsule. By a sufficiently free dorsal incision the extensor tendon can be readily separated from the bones beneath. In the case of recent dislocation the surgeon, when the joint is opened, should examine into the cause of the irreducibility. Thus, in the case of the metacarpo-phalangeal joint this may be the glenoid ligament detached and stretching across the head of the metacarpal bone. After vertical division of this, reduction may be at once possible. (Davies-Colley, Symonds, *Lancet*, 1888, vol. i. p. 522; Jordan Lloyd, *Lancet*, 1892, vol. i. p. 469. The two cases here given will repay perusal.) If it is necessary to go farther, the lateral ligaments having been severed, the joint is dislocated, and the ends of the bones removed with a narrow, clean-cutting saw, the soft parts being as carefully protected from damage as possible.* The surgeon should always remove the bone freely, and not content himself with paring off the articular surface, which risks the formation of a stiff joint. Drainage having been provided with a strand of aseptic horsehair, the wound is partly closed, and the finger put up somewhat flexed.† Careful passive movement should be commenced about the third day, gas or ether being given if necessary. The patient must be prepared, especially if an epiphysis have been removed, for subsequent shortening.

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* In a case of Mr. Turner's (*Clin. Soc. Trans.*, vol. xxi. p. 170) it was a very tense long flexor, which had slipped to the inner side of the metacarpal bone, and thus prevented reduction until pulled up with a blunt hook. Mr. J. C. Wordsworth long ago (*Lancet*, 1863, vol. ii. p. 443) published a case showing that the difficulty in reduction of this dislocation was sometimes due to displacement of the long flexor tendon. MM. Duplay and Reclus (*Traité de Chirurg.*, t. iii. Fig. 133) illustrate this from a specimen of M. Farabeuf's (*Bull. de la Soc. de Chir.*, 1878, p. 457), which shows extremely well the head of the metacarpal caught between the outer head of the flexor brevis on the one side, and the long flexor and the inner head of the flexor brevis on the other.

CONSERVATIVE SURGERY OF THE HAND.

While every case must be decided by itself, I trust that the following may be of service to my younger readers when called upon, suddenly, to form what is one of the most important decisions in all surgery.

i. **The question of trying to unite a totally separated part** is alluded to at p. 18. The question of palmar hæmorrhage is considered at p. 26; and the treatment of injuries to tendons and nerves will be found under these headings respectively.

ii. Save in the very rarest cases, where the combined comminution of bone, injury to tendons, and stripping off of skin is extreme, no **set amputation** is to be performed. In the case of a part of such incalculable value, and so well supplied with blood as the hand, the surgeon should remember Verneuil's words and not "approach these cases with the bistoury." He is to render the parts as thoroughly aseptic as possible (p. 17), and then to wait and see what Nature will do towards **the ultimate restoration of usefulness.**

Speaking generally, these cases, in which the decision has to be made between too conservative surgery and in removing too much, fall into two groups. A. **Injuries limited to the fingers.**—Here conservative surgery is less rigidly indicated than in complicated and extensive injuries to the hand. If the injury to the finger, especially the third or fourth, be such that useful function will be lost, it will be wiser to amputate it, and not hold out any hopes of usefulness, which will only prove illusive. If it be the index which is most damaged, the surgeon will remember that a freely movable middle finger will steadily improve in sharing with the thumb the loss of the index. And if the head of the metacarpal bone has been removed, a new interdigital space will gradually be developed, which may be very useful for a working man. B. **Complicated and extensive injuries to the hand.**—Here the difficulty of estimating the extent of the damage, the power of ultimate recovery in a part like the hand, and the amount of loss of function, together with the hopelessness of any really useful artificial substitute, should make conservative surgery the rule, and the surgeon should wait and see how much antiseptic baths and dressings, together with the other aids given below, will save from destruction.

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* If any tendons are cut, they should be united with sutures (p. 31).

† In a carefully moulded felt splint, or one of perforated zinc.

iii. But while it is a cardinal principle to preserve every inch of the hand, a single finger or a thumb alone being far more useful than the most elaborate artificial limb that can be made, and while to gain this end it is frequently advisable to trim up an injured part and to remove bone in preference to doing any set amputation, it must always be remembered that **a part may be capable of being saved, and yet ultimately be useless, unless it be at least partially movable.** Again, atrophy of a part, at first promising in usefulness, may set in some time after the injury, brought about largely by trophic disturbances. In either of these cases a rigid, cicatricially contracted claw, or a pointed, sensitive, and shrunken part may call, later on, for amputation.

iv. Amongst the **very exceptional cases which call for primary amputation** are those where (1) one or more fingers are mangled and pulped out of all shape or recognition; (2) where all the tendons are torn through, especially if this has happened at more than one place, as in the fingers and in the palm also, and where with these injuries there is much opening of the joints as well as fracture of the bones and ripping off of the skin; (3) where the fingers are extensively split longitudinally (Fig. 6); (4) another condition, which surgeons in large manufacturing centres are certain to meet with, requires grave consideration—*i.e.*, where a hand is flayed, owing to its having been caught between rollers which hold, but do not crush: here, as the patient draws back, the skin is stripped off, like a glove, up to the wrist. If, in addition, bones are crushed, the palmar thecæ opened, amputation, leaving part of one finger, if the thumb is intact, or through the wrist-joint, should be performed at once; and Billroth (*Lect. on Surg., Pathology, and Therapeutics*, Syd. Soc. trans., vol. i. p. 207) advises this step where the skin is completely stripped off without other injury, fingers entirely deprived of their skin almost invariably becoming gangrenous, and the result being "under the most favourable circumstances, nothing more than an unwieldy cicatrised stump."

The following case (Dr. Gregory, of St. Louis, U.S., *Trans. Amer. Surg. Assoc.*, vol. ii. p. 232) is a good instance of the truth of the above:

"The hand of a little boy was caught in the rolling machine of a bakery, and the skin divided at the wrist, just as cleanly as if it had been done by intention, and an entire glove of the skin taken off. When I saw it, it was held on by the tips of the fingers only. There was no injury other than that described. I felt satisfied that amputation was proper; but the patient insisted that he was willing to take the risk if amputation was not performed, and I replaced the flap, and stitched it in several places, believing that it would slough. It did slough, and he lost his fingers up to the knuckles, and the only part that was saved was a small portion of the thumb, and the metacarpal portion of the hand. This, of course, was a cicatricial surface, which I covered with grafts, and it finally healed. The boy can hold a pen in a little groove by the side of the thumb, and it is probable that the remnant of the hand will finally become useful."

The explanation of the certainty with which the stripped-off skin dies in these cases, and the uselessness of the most careful stitching, lies in the fact that not only have the vessels passing from the deep parts to the skin been torn through, but the skin itself has been submitted to an enormous strain and dragging.

In such cases where it is clear the glove-like skin must go, an attempt should be made by skin-grafting, after Thiersch's method (p. 188), to provide a covering, and prevent the sloughing of the deeper parts.

v. **Skin-grafting** is especially to be made use of where, after an injury to the hand, it may be possible to save one or two fingers only, or, particularly, the thumb and index finger, by taking skin, if possible, or a pedunculated flap, from the damaged hand, from the opposite arm, or the belly, or, as I prefer, by large grafts taken by Thiersch's method (*q.v.*) from the shoulder. Dr. Schreiber (*Münch. Med. Woch.*, Aug. 19, 1892) advises skin-grafting in smaller injuries. Thus, if the skin be torn away from the dorsum of a finger, over-extension will follow when the wound is healed unless it is grafted. On the other hand, if it be the pulp that is torn away, successful grafting will give a rounded, sensitive, fleshy end, instead of a thin, sensitive, pointed one. The surgeon must, of course, prepare his patient for disappointment. The grafts may die, and the injured part be reduced to a claw, active movement largely disappearing. Skin-grafting may also be made use of later on if one or more fingers become contracted, and division of the cicatrix leave a gaping wound.

In some cases the method of *désossement* of French surgeons will be useful in supplementing or replacing skin-grafting. Supposing that in a case of severe laceration, in which it is determined to try and save the hand, one finger requires amputation; by turning out the bone, removing the nail and tendons, the soft parts may be utilised in filling up any large gap below. The incision, *en raquette*, is made along the dorsum or palmar aspect according as it is desired that the soft parts of the finger should fall into place along the back or front of the hand.

vi. **Injury to Joints.**—Where the tendons are uninjured, or can be sutured, where there is no extensive comminution of bone or great injury to the skin, the finger will, of course, be saved. If expectant treatment is adopted, even if the parts heal quickly, the surgeon will be fortunate if he manages to preserve for his patient half the natural range of movement of the joints affected. And, to do this, splints—these should be of perforated zinc or gutta-percha, not of wood—will have to be frequently changed, the part being put up for a short time flexed, then extended, massage assiduously employed, &c.

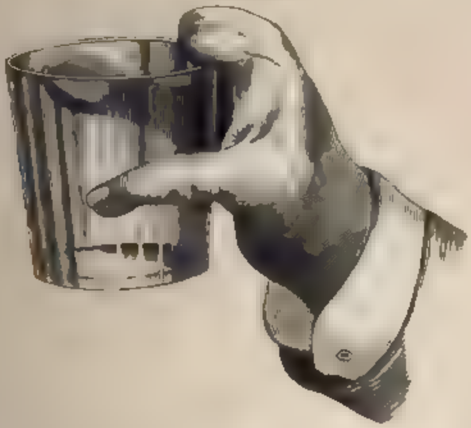
I am of opinion that excision of a joint which has been freely opened will restore better movement if the patient is brave and persevering. It should certainly be tried—and removal of the bones carried out sufficiently widely to prevent any risk of ankylosis—in the case of the joints of the thumb (p. 13).

vii. **Injury to Tendons.**—This is fully considered at p. 30.

viii. To sum up the chief points:—Primary amputations, especially what may be called formal operations, are only to be made use of under the very rarest circumstances: any surgeon who makes use of them will almost always find that he has overstepped what was absolutely needful. The part should be thoroughly cleansed (with the aid of an anæsthetic), by means of turpentine and soap, with a nail-brush, and lotio hydr. perch. (1 in 2000), lysol (2 p.c.), or creolin (2 p.c.); these solutions being used continuously hot in an arm-bath. The hopelessly damaged soft parts should be trimmed and drainage provided. It is only by great care here that the surgeon is justified in submitting his patient, during the attempt to save a mangled part, to the risks of sepsis, gangrene, tetanus, &c. If there is any doubt as to the completeness of the cleansing, the part should be kept in an arm-bath with a weak aseptic lotion, constantly renewed. But it is always advisable to get the wound sweet and safe under adequate dressings and at rest on a splint as soon as possible. If any part must be amputated, a flap of skin or tendon that may be useful is to be transferred to the parts that are being saved. So, too, later on, if a surface is left, which by cicatrising slowly will lead to distortion, or if tendons exposed have fibrillated and died, an attempt must be made to cover the one by flaps taken close by or from a distance, and replace the other by distance-sutures (p. 36). Secondary operations will also include removal of any painful stumps, especially those which interfere with the approximation of the thumb to another finger.

The following (Fig. 13) is an excellent instance of what may be effected by conservative surgery here. It represents the remains of a hand, consisting of the thumb, stump of the index and of the little finger, and also shows of how much flexion the shortened index is still capable.*

FIG. 13



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* The figure is taken from a paper on Railway Injuries, by Dr. Thomson, of Kentucky. *Trans. Amer. Surg. Assoc.*, vol. ii. p. 190.

RE-UNION OF SEVERED DIGITS.

The question will sometimes arise as to the advisability of attempting to re-unite portions of severed fingers and thumbs.

Many such successful cases have occurred, and the surgeon may well make the attempt, when the parts are cleanly severed, through a phalanx, especially the distal one; and when the patient is young and healthy, as is often the case in country practice: when the cut has passed through a joint, not through a phalanx, the outlook is far less promising.

The following are instances of the parts severed:

The first, second, and third fingers cut off above a diagonal line beginning in the middle phalanx of the index finger and ending in the last phalanx of the third finger near the root of the nail. The parts had been lying in the snow for some time and were kept for two or three hours before being applied. In other cases the part has been severed longitudinally, containing in it a portion of bone split off. The time between the injury and the treatment has varied from twenty minutes to three or four hours, and the severed part has been picked out of sawdust, brought up in dirty paper, whilst in a third the patient was sent back to find it in the field in which he had been reaping.

When there is the least shred of soft parts left holding on the severed bit, even a bad compound fracture of the finger with severe laceration of the soft parts may be saved.

The age and condition of the patient, the time which has elapsed since the injury, the part affected—*i.e.*, whether the index or the thumb—must all be considered. And in any case the patient should be warned that, though the attempt may succeed, the parts unite, and sensation be restored, the result may be a stiff and therefore comparatively useless member.

If it be decided to make the attempt, the part should be carefully cleansed with soap and water, turpentine, hot mercury perchloride solution (1 in 2000), united exactly with a few points of fine wire or salmon-gut and horsehair sutures, enveloped in aseptic wool, and kept *in situ* with carefully adjusted splints of whalebone or perforated zinc. The dressings should not be disturbed for at least three days, if possible.*

SUPERNUMERARY DIGITS.

This congenital deformity is sufficiently common and important to require a brief notice. The chief point of importance, from a practical point of view, is the mode of junction of the supernumerary digit. This, consisting of two or three phalanges, may be joined by mere fibrous tissue; in other cases there may be a complete articulation between it and the side of an adjacent metacarpal bone, or the carpus, a metacarpal bone being usually present, in addition to the phalanges, in the latter case. Lastly, the allied condition of a *supernumerary phalanx* may be present in cases where the terminal phalanx of a thumb or finger is bifid.

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* Numerous cases of this kind will be found in the *Lancet* for 1861, vol. ii., and later (*Annals of Surgery*, March, 1887, p. 263). fifteen such cases, with good results, have been tabulated by Dr. Pilcher.

Treatment.—This consists of amputation with strict aseptic precautions, so as to secure primary union and a perfect scar in a part where a deformity is so noticeable, and also to prevent the risks of serious sepsis when a joint is opened. In each case the finger is removed by an elliptical incision, the flaps being cut so as to meet exactly; where the union is fibrous, this is all that is required. But where an articular surface is present, this must be exposed after disarticulation of the finger, and sufficient of the joint chiselled or cut away with strong scissors so as to leave the surface of the bone plane and uniform; otherwise growth will continue at this spot up to adult age, and a very unsightly deformity may be produced. When the articulation is with the carpus, additional care is required in carrying out the above steps.

In the case of a bifid phalanx the treatment involves more trouble on the part of both surgeon and patient or the friends, if the result is to be satisfactory. That portion of the phalanx which is the largest, which diverges least from the straight line, and which carries the best-developed nail (if these three points coincide) is to be preserved, and the other one removed. In carrying out this step, if the phalanx be not completely bifid, it should be split down through its base with bone-forceps or strong scissors, and the part to be removed taken away. Any ligaments or structures which will prevent the part left from being brought into the straight line should be divided. As soon as the wound is healed, careful movements of the joints and bringing the phalanx into the straight line must be practised every few days, and a circular splint worn round the wrist, with a lateral projection coming up along the affected finger or thumb on the side away from that to which the phalanx projects; by this means the phalanx which is at fault can be drawn straight. But persevering treatment for four or six months will be required.

WEBBED FINGERS (Figs. 14, 15 and 16).

These should always be remedied in early childhood; if left untouched, the fingers may be useful, but the annoyance of the deformity will be serious. The surgeon should not yield to pressure put on him to operate in early infancy. Simple division of the web—a trifling operation—is out of the question owing to the inevitable recurrence of the deformity. On the other hand, especially if extensive dissections are made in raising flaps, the loss of blood will be considerable, and not without risk both as to the vitality of the flaps and of the infant itself. No operation should be undertaken before the child is two or three years old.

As is stated below, the variety of the uniting medium will, to a certain extent, affect the operation chosen; thus, whether the web is lax and free (Fig. 14), or close and thick (Fig. 16), or whether two fingers are fused together by bony union.

1. The simpler methods—viz., wearing a large metal ring through a hole made where the cleft should begin, or passing large silver-w
fine drainage-tubing through such a hole, the ends of the tubin
attached to a wristlet or bracelet, and the wire twisted in a loop
adjacent finger—one of these may be tried first, and tubin

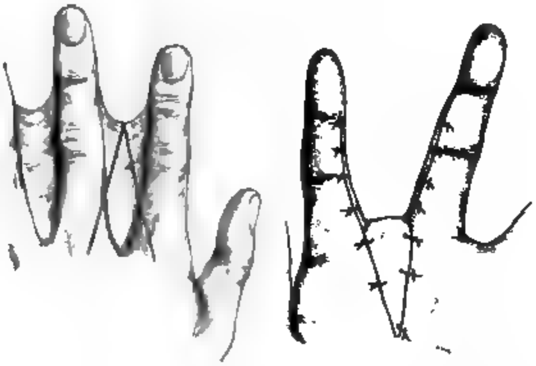
advantage of allowing the hand to move more freely. When the perforation is soundly healed—*i.e.*, in about four weeks—the web should be slit up, each half split, dissected up for a little way, and the edges of the two flaps thus formed united with a few points of sterilised horsehair. A sharp-pointed probe will be needed to keep the protruding fat in place. The fingers should be kept apart throughout the healing.

This method has the disadvantage of being tedious, and the formation of epidermis round the foreign body is liable to be incomplete.

2. If the above fail, one of the following plastic operations should be made use of:

Agnew's or Norton's* (Figs. 14 and 15).—Small triangular flaps are raised in Norton's operation, on the dorsal and palmar aspects; the webs are then cut through and the flaps very carefully stitched together without tension. The object is to ensure rapid union in the commencement of the cleft, and thus no re-development of the web. A better plan, Agnew's, employs a single larger flap (Fig. 14) raised from the dorsum. The flap should be thick enough to avoid risk of sloughing, and somewhat narrow to prevent bulging. To prevent tension it should be sufficiently long, its bases being at the level of the metacarpo-phalangeal joints, and its apex almost reaching to the base of the second phalanges. Any tissue between the knuckles that prevents their coming together should be cut away. The remaining web is then split, and treated as above described. The line of the natural web should be carefully observed.

Fig. 14.



Agnew's operation for webbed fingers. The flap is dorsal, large, and single. (Keen and White: *American Text-book of Surgery.*)

Didot's (Fig. 16).—Two narrow longitudinal flaps are dissected up as thick as possible from the palmar and dorsal aspects of the affected fingers, and each flap is then folded round to cover in the raw surface of the finger to which it is attached, and secured with a few points of interrupted sutures of very fine sterilised salmon-gut and horsehair.

Didot's, like many French operations, is most ingenious, and, on paper, it looks an excellent one. But, in practice, the following objections will present themselves: (1) It is a severe operation, especially in little children. (2) It is not easy to raise satisfactory flaps in parts so small and with skin so little developed. Thus, if the flaps are thick enough, it is easy to injure the extensor tendons or digital nerves or vessels, and thus to run the risk of necrosis of the terminal phalanx; on the other hand, if the flaps are too thin they slough, and sepsis readily occurs. (3) The flaps are nearly always insufficient to cover the denuded surfaces unless they are submitted to such tension as will lead to sloughing. Thus in part the wounds must heal by granulation, which may lead to harmful scars, or by the aid of skin-grafting, which is liable to be rendered futile by the restlessness of the patient. (4) Considerable difficulty will be met with in fitting neatly the quadrangular edges of the flaps at the roots of the fingers so as to satisfactorily re-establish the web.

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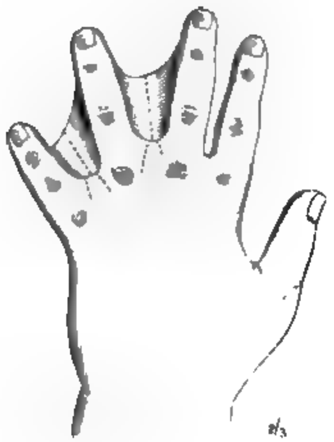
* *British Medical Journal*, 1881, ii. 931. On the Continent this operation goes by the name of Morel-Lavallée. A similar proceeding is that of Zeller or Agnew (Fig. 14), who, to avoid trenching on the palm, have advocated the use of a single dorsal flap.

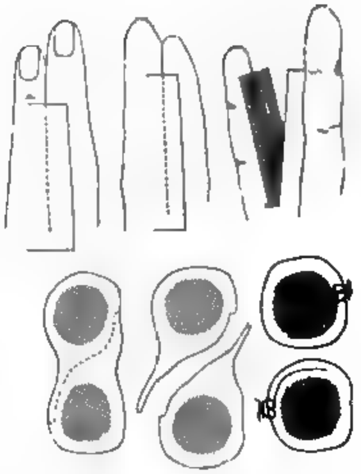
For the above reasons I prefer the method of operating by a triangular flap (Fig. 14) wherever the web is loose enough to render this feasible.

FIG. 15.



Norton's operation for webbed fingers. The flaps are small and double.

FIG. 16.



Didot's operation for webbed fingers. (Reeves.)

In those rare cases where the union is bony, the choice lies between (*a*) leaving things as they are, or (*b*) removing the bone of one of the united fingers after exposing this adequately by two rectangular flaps, dorsal and palmar.

After all operations on webbed fingers, especially the one last described, there is more or less tendency for the fingers to become stiffly flexed or extended, according as any excess of scar has formed on the palmar or dorsal surface. This must be met by persevering use of a splint, one similar to that mentioned at p. 22 being applied to the dorsal or palmar surface of the finger as required. At first it must be worn day and night, and then removed for varying periods in the day to admit of active and passive movements being assiduously practised. It will require to be worn at night for many months.

CONTRACTED PALMAR FASCIA (Figs. 17, 18 and 19).

It is well known that occasionally contraction of the palmar fascia takes place, especially that part of it going to the inner two fingers, being due partly to constitutional, partly to local causes. Commencing about the transverse palmar creases, it steadily cripples the hand by drawing down the fingers, causing flexion, first at the metacarpo-phalangeal, and later at the inter-phalangeal joints (Fig. 17).

Operation.—This may be either subcutaneous or open; I much prefer the former.

A. **The Subcutaneous.**—The best is Mr. Adams' method,* by multiple punctures from the surface downwards. The skin must first, for a day or two, be carefully prepared and cleansed. Finding some spot where adhesion of the skin to the fascia has not yet taken place, the surgeon, avoiding the site of the vessels, passes a delicate fascia-knife, or a fine, small tenotomy knife, between the skin and fascia, and divides the band from above downwards, taking care not to dip the point. If too much straightening is attempted at once, the punctures will gape widely and readily tear, especially where the skin and fascia are adherent. In cases of contraction of two fingers, multiple punctures —*e.g.*, five to nine—may be required. It is very easy, by operating on the palmar cords, to rectify the contraction at the metacarpo-phalangeal joint. The straightening of the contraction often met with between the first and second phalanges is much more difficult. The digital prolongations of the fascia may be divided by punctures in the web between the fingers, extreme care being required to avoid the digital vessels and nerves by not dipping the point, and keeping to the middle line. But when the surgeon finds some difficulty in correcting this contraction thoroughly, I am of opinion that he will act most wisely by correcting the remaining contraction gradually by the use of Mr. Adams' finger-splint with rack and pinion movements opposite the metacarpo-phalangeal and inter-phalangeal joints.† The skin should be first most carefully cleansed, and an aseptic dressing applied for three or four days, when the punctures will be practically healed. The splint should be worn day and night at first, carefully padded at all pressure points. Some weeks will be required to correct the phalangeal contraction, and in advanced cases relapses can only be prevented by the persevering use of the splint. If the surgeon attempts to straighten completely an advanced case of phalangeal as well as metacarpo-phalangeal contraction, he runs the risk (1) (by dividing a digital nerve) of causing slight gangrene of the finger-tips or most intolerable pain, and (2) of damaging the tendons, for sometimes these bands are closely related to the theca in the fingers.

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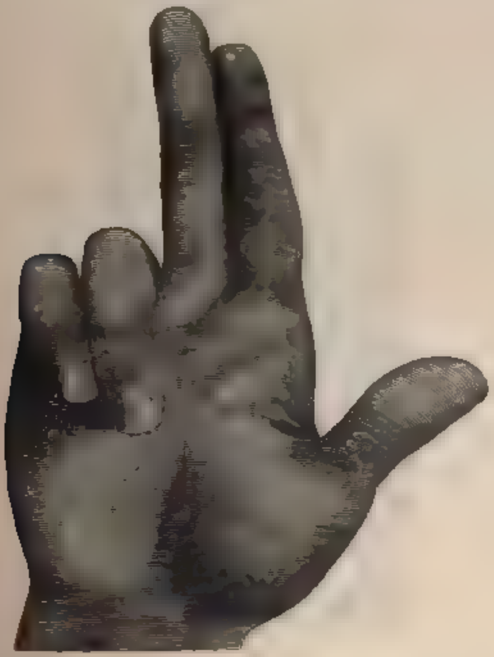
* *Finger Contraction and Depressed Cicatrices* (Churchill, 1892).

† *Loc. supra cit.*, Fig. 10. Other splints will be found figured by Mr. Adams, *Lancet*, 1891, vol. ii. p. 166. Mr. Anderson (Hunt. Lectures on "Contraction of the Fingers and Toes," *Lancet*, 1891, vol. ii. p. 58) uses plaster of Paris for rectifying the position of the fingers at once, when the skin is sound. If this has been much strained, the straightening should be deferred for a few days.

For fear of relapses the patient should, regularly and methodically, practise active and passive movements of the joints, wear the splint at night for a considerable time, and if any persistent or recurrent bands threaten to be troublesome, treat these by blistering and rubbing in oleate of mercury, vaseline, &c. Any employment involving much local pressure and irritation should be avoided: and if the patient be the subject of the gout of the present day, if he take too much alcohol, &c., he must be advised accordingly.

Figs. 17 and 18* represent a right hand crippled with contraction of the palmar fascia, before and five years after operation. The man was a patient of Dr. J. E. B. Burroughs, of Lee, and was operated on by me in 1883, the contraction of the metacarpo-phalangeal joints being straightened at once after numerous punctures made in the manner above given, while that at the inter-phalangeal joints was remedied chiefly by the persevering use of Mr. Adams' splint, already alluded to. In 1890 the fingers could be completely extended, were perfectly mobile, and free from the slightest tendency to contraction. It will be [illegible] from Fig. 18 that some thickening, puckering, and corrugation of [illegible] lmar skin and fascia still persists, but this had now no power of [illegible] contraction, the patient, one of the relieving officers to the [illegible], being able to write, &c., without any hindrance

FIG. 17.

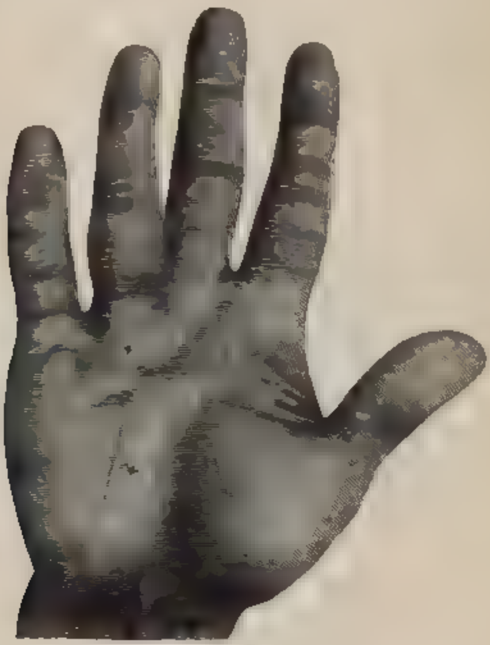


[illegible] g. 18 show spots where the fascia-knife might be introduced in [illegible] ar fascia slip going to the ring-finger. The contracted band or [illegible] se punctures, undergoes softening and atrophy.

whatever. But, to show the importance of persevering in the after-treatment mentioned above, when, after another four years, I again saw the patient, in 1894, there was some recurrence of the flexion of the inter-phalangeal joints. The above advice, on which I had insisted, had been entirely neglected.

B. **Operation by Open Wound.**—If this be preferred, the method advocated by Goyrand, Kocher, and others may be made use of. It has been recommended by Mr. Hardie,* of Manchester, who believes that mere subcutaneous division of the contracted palmar fascia cannot be sufficient if the thickened, puckered, hardened skin is left alone, and also that intimate adhesion of the altered skin to the fascia is so general that it is difficult, if not impossible, to get the knife between the two at a sufficient number of spots for adequate straightening by the subcutaneous method. While it may be readily admitted that Mr. Hardie's four cases gave good results up to the time reported, and that, if any open operation is really needed, this one is as good as any, I think that the following are great objections to its general adoption in preference to that of Mr. Adams: (1) The greater severity of an open operation in these patients, who are often not young, even when the wound is, by hands as careful as Mr. Hardie's, kept aseptic. (2) The more frequent dressing, the possible need of a drain, the fact that the wound does not

FIG. 18.



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* *Medical Chronicle*, vol. i. No. 1, p. 9. A diagram of the different incisions, which may be found useful, according as the band is linear or branching, is given by Mr. Anderson (*loc. supra cit.*), *Lancet*, 1891, vol. ii. p. 59.

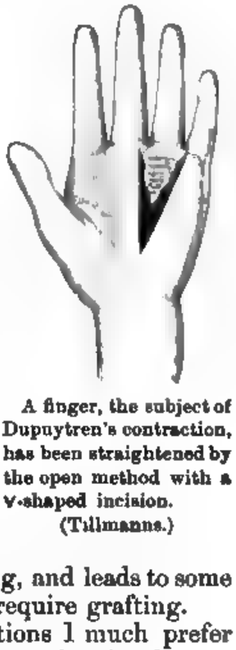
heal for upwards of a week, and then, perhaps, not all by primary union; the presence of sutures which need removal, and the fact that, as in Mr. Hardie's second case, "general swelling of the hand"* may take place and interfere with the use of splints. Finally, Mr. Hardie does not appear to me to attach sufficient importance to the value of Mr. Adams' splint, which, by gradual, quiet, persevering extension, causes atrophy of the now divided fascial cords, and thus renders, as a secondary result, the hardened skin over them more soft and supple, this taking place the more readily, the more extension by the splint, and passive movements, frictions, &c., are persevered with.

The open method should, in my opinion, only be employed where the subcutaneous method has really failed, or where the skin is too extensively adherent and nodular to admit of the punctures being made satisfactorily.

The Open Method, if preferred, may be performed in one of two ways.

(*a*) **Excision by Dissecting out the Contracted Bands.**—The skin having been, for two days at least, softened and sterilised as much as possible, a longitudinal incision is made over the contracted band from its upper to its lower limit, and then small transverse incisions are made at each end of the longitudinal one so that small rectangular flaps may be dissected up. A twofold difficulty at once presents itself: the skin is usually so adherent in places that the satisfactory making of these flaps is by no means easy, a difficulty much increased by the flexed position of the finger affected. The band of contracted fascia, when exposed, is dissected out, all bleeding arrested, and the flaps united with sterilised horsehair. Another difficulty presents itself here owing to the contraction and adhesion of the skin which has to be united. Where union is impossible, skin-grafting must be employed: any surface left to granulate means more or less recurrence of the troubles.

Fig. 19.



A finger, the subject of Dupuytren's contraction, has been straightened by the open method with a V-shaped incision. (Tillmanns.)

(*β*) A V-shaped Incision (Fig. 19).—The base of the V is opposite to, a little above and overlapping the root of the affected finger; the apex is situated in a line with the centre of the same finger, in the palm, about on a level with the highest transverse crease. Two diverging incisions join these points, and are carried down through the skin and fascia. As soon as the latter is divided completely the finger can be straightened. This leaves a gaping triangular wound in the palm, with its apex upwards. Theoretically, this should be united by careful stitching in the form of a Y. But the contracted state of the skin almost always prevents accurate stitching, and leads to some gaping of the wound, and a raw surface which will require grafting.

On account of the above difficulties and objections I much prefer the subcutaneous method by multiple punctures, repeating it after an interval, if needful, in severe cases. For such cases Messrs. Watson Cheyne and Burghard (*Manual of Surgical Treatment*, part ii. p. 23) recommend a combination of the subcutaneous method and the V-shaped incision. "In very advanced cases, where the fingers are tightly bound down to the palm, removal of the fascia by dissection cannot be performed, because it is impossible, on account of the contraction of the fingers, to get proper access to the palm so as to make the requisite incisions. Under these circumstances the best treatment is to perform tenotomy* in the first instance, and to get the finger as straight as possible by these means.

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* Gouty inflammation of the hand may follow operations by either method.

"As a rule, however, tenotomy will not allow the finger to come quite straight, because the skin itself is contracted, and therefore the result is incomplete. The operation by the V-shaped incision may be very usefully combined with tenotomy so as to compel the straightening of the fingers. The two operations should, however, be done at different times. The result of the tenotomy is to endanger the vitality of the skin at various points; this, however, very rarely sloughs, unless too great pressure be brought to bear upon it. Hence a sufficient time must be allowed to elapse between the tenotomy and the open operation to allow these damaged portions of skin to recover, and during this time the fingers should be kept somewhat extended on a splint; three weeks' interval is usually enough."

It cannot be too strongly impressed on the patient that, whatever operation is performed, and however successful may be the immediate result, recurrence is certain unless extension is kept up at night, at intervals.

PALMAR HÆMORRHAGE.

There are three arterial arches especially concerned in keeping up the arterial supply here—viz., (*a*) superficial palmar; (*β*) deep palmar arch; (*γ*) the carpal arteries around the wrist. These are supplied with blood, not only from the radial and ulnar, but also from the interosseous arteries. Finally, if the comes nervi mediani is enlarged, it will join the superficial palmar arch, or one of the digital arteries.

Treatment.—This will vary accordingly as the case is seen early, or later.

A. EARLY CASES.—The surgeon arrests any bleeding† by pressure on the bleeding point while he has the limb raised, and arranges for compressing the brachial, or the radial and ulnar. This securely effected, he thoroughly cleanses the wound and adjacent parts, dries them carefully, and, if the wound gapes at all, endeavours to secure the cut vessel itself. If this fail, or if the wound be merely punctured, he at once carefully applies compression. And it may be said at once that, if this be wisely and efficiently done, no further hæmorrhage will take place; if incompletely or carelessly applied, the patient's limb and life may both be endangered (*vide infra*).

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* Division of the fascia is meant.

† The wound sometimes does not bleed when examined. If there is a history of much bleeding, bleeding *per saltum*, if the depth, &c., of the wound make it probable that an artery is wounded, pressure should be applied. A little later, and the hæmorrhage may break out on the least exertion; this is very likely to occur at night.

The brachial having been commanded and the wound cleansed, a compress—consisting of a sterilised pad, gauze, or lint sufficiently soaked in lysol (2 p.c.), or, failing this, lint soaked in carbolic oil (1 in 20), or tr. benz. co., the pieces of iodoform gauze or lint increasing in size from a threepenny-bit to half-a-crown—is got ready, together with strapping, gauze bandages, and two bits of pencil or bougie. The fingers are now carefully strapped and bandaged, and the compress is then secured in position by careful bandaging. If the above precaution be omitted, so much and so painful œdema of the fingers will take place, as to inevitably lead to early removal of the compress and recurrence of the hæmorrhage. The compress being in position, two bits of pencil wrapped up in gauze are placed over the radial and ulnar arteries, and the bandage carried up to mid-arm. The Esmarch's bandage having been removed from the brachial, a splint is then applied, and the patient kept at first well under the influence of morphia, the limb being kept well raised. The compress should not be disturbed for three or four days at least.

B. LATER CASES.—If pressure has been tried, but inefficiently because inadequately at first, together with imperfect cleansing of the wound, inflammation will probably have supervened, and the hand will very likely be red, brawny, painful, suppurating. If hæmorrhage still continue after the parts have been relieved by carefully made incisions* it will be wiser to tie the brachial artery at once in the middle of the arm (p. 113) than to tie the radial and ulnar in the lower third of the forearm (pp. 67, 69), and for these reasons:

i. While the anastomoses round the elbow are so free and so reliable as to prevent any risk of gangrene after a ligature of the main vessel, ligature of the radial and ulnar is rendered uncertain owing to—

(α) The anastomoses between the two palmar arches; (β) The anastomoses between these and the carpal arteries; (γ) The blood brought down by the interosseous arteries and the comes nervi mediani, which will not be stopped by ligature of the radial and ulnar; (δ) The fact that, if inflammation has set in, enlargement of the arteries will have taken place.

ii. Ligature of the brachial, by cutting off so much blood, will also cut short the inflammation.

iii. Ligature of the brachial will be performed through healthy and uninflamed parts.

An interesting instance of what pressure will effect even if deferred till the eleventh hour is seen in the following case:

A patient, nearly three weeks after the wound, having had attacks of recurrent hæmorrhage, entered St. Bartholomew's Hospital, and Mr. Skey tied the radial and ulnar. When the ligature separated from the ulnar, hæmorrhage took place, and the artery was again tied in the middle third. Hæmorrhage recurring, the brachial was tied in the lower third. This last operation failed to arrest the hæmorrhage, and the third part of the axillary was tied. About ten days later profuse hæmorrhage from the axillary wound left the patient almost pulseless. The patient's condition not admitting of amputation at the shoulder, the limb was firmly bandaged from the hand to the shoulder. No further bleeding took place, and the man made a good recovery, with a useful arm. (*Lancet*, 1855.)

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* Incisions for suppuration in the hand should be made opposite to the centres of the phalanges, opposite to the heads of the metacarpal bones, above the superficial palmar arch by Mr. Hilton's method, and, if above the wrist, the position of the arteries, which may, perhaps, be superficial, and of the median nerve, lying close to the inner side of the palmaris longus, must be remembered.

In the *Lancet*, 1859, vol. i. p. 506, is recorded the following good instance of the results of pressure inefficiently applied:

The compress, which had been applied to the palmar wound (the man having been made an out-patient), was removed every day, and followed by hæmorrhage. Severe bleeding occurred on the fifth day, ligature of the radial was performed on the seventh, and on the ninth ligature of the brachial low down. On the eleventh, owing to recurrence of hæmorrhage, the arm was amputated just above the ligature. Chronic pyæmia followed, from which the patient was slowly recovering at the close of the report. No abnormal distribution of vessels was found in the arm.

PALMAR GANGLION.

Practical Points.—(1) There is the risk of spreading sepsis if the wound be not kept carefully aseptic. (2) Recurrence is very frequent, from the fact that it is difficult to remove all the "melon-seed" bodies which are often present in great abundance. However few may be left behind, these will suffice for continued effusion of fluid, weakening of the ligaments,* and, perhaps, ultimate disorganisation of the joint. (3) This form of ganglion is often tubercular. In these cases disease of the carpus is almost certain to follow.

Treatment.—This will vary according as the disease is recurrent, inveterate, or tubercular.

A. In cases where the disease is not tubercular, where it has resisted palliative treatment, but has not been operated on before, simpler steps should be first tried. The parts having been rendered aseptic, an incision should be made 1½ inch above the anterior annular ligament, avoiding the median nerve, and going down into the ganglion, the deep opening into which is not to be a mere buttonhole, but must be kept free and dilated, otherwise the complete carrying out of the next step, on which a cure depends, will be found impossible. This consists in removing all the "melon-seed" bodies, partly by pressure, partly by the use of a sharp spoon, which should explore all the cavities into which these ganglia are sometimes divided. Thus care should be taken to examine and treat, if needful, the synovial sac enveloping the flexor profundus as well as that in relation with the superficial flexor. The question of providing a second opening below the anterior annular ligament will now arise. Where the ganglion is a large one, where the "melon-seed" bodies are numerous, where it is desirable to provide thorough drainage, a second opening should be made. This may be safely done by passing a bullet-probe from the upper opening under the annular ligament, and cutting down upon it through the palmar fascia, the palmar arch being avoided. This opening having been enlarged with dressing-forceps, the sharp spoon is again applied, if needful, and when, either by this means, or by rubbing between the openings a strip of iodoform gauze which has been kept in a solution of 1 in 20 carbolic acid, all the "melon-seed" bodies are detached and removed, the cavity is washed out with a solution of carbolic acid (1 in 40) or hydr. perch. (1 in 2000)—whatever fluid is used all of it should be withdrawn—and then a drain of sterilised horsehair is passed by means of the probe from below upwards. Strands of this may be withdrawn as needed. The hand may be conveniently put up with the fingers flexed, as on a Carr's splint. All should be healed in three weeks, at which date movements, which may be cautiously begun before, should be actively persevered with.

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* If for any reason the operative treatment of compound ganglion is deferred, some well-adjusted form of support and compression should be worn, otherwise delay will lead to dangerous stretching of the ligaments and weakening of the joint.

B. Where the disease recurs, or where there is reason to suspect tubercular mischief, further steps will be required in order to prevent the mischief extending to the carpus. The ganglion having been opened by the steps given above, its walls will probably be found to be thick and velvety, with vascular fringes over the tendons. In such cases each of the tendons must be separately hooked up and cleaned with curved, blunt-pointed scissors and dissecting forceps. To eradicate the whole of the tubercular mischief it will be needful to divide the anterior annular ligament,* the position of the median nerve being first carefully noted. In spite of the weakening of the hand that will follow, where there is reason, from the family or personal history, the obstinacy of the disease, or the aspect of the interior of the ganglion, to suspect tubercular mischief, the incision must be boldly made from about 1½ inch above the annular ligament down through this structure to a point just above the level of the superficial palmar arch. Otherwise there is danger that, by insufficient exposure of the parts, persistence of the tubercular mischief, and, ultimately, disease of the carpus, may ensue. When by the use of the scissors or sharp spoon all the mischief has been eradicated as thoroughly as possible, the surgeon examines for the presence of bone disease, flushes out the parts with the above-given solutions, followed by a good dusting in of iodoform, or, instead of the above fluids, a thorough rubbing in of sterilised powdered iodoform made into a paste with lotio hydr. perch. (1 in 1000). During the operation every bleeding-point must be arrested by ligature with fine sterilised chromic gut. The use of forci-pressure is less advisable owing to the risk of damage to the tendons. The annular ligament is then united with buried sutures of aseptic chromic gut, or kangaroo-tail tendon, and dressings applied with uniform pressure, so as to distribute the discharges, which will probably be free, through as wide a surface as possible.

After this operation movement of the fingers must be begun as early as possible, to prevent the tendons being matted together after all the interference which is needful at the operation.

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* In 1896 I made use of this step in a tubercular palmar ganglion in a woman æt. 53, who earned her living by working at fancy embroidery. When I last saw her, thirteen months after the operation, the parts remained sound, and the patient was able to follow her employment. More recently I have operated in a similar case, though no bacilli could be found in the numerous "melon-seed" bodies, or the thickened synovial sac. The woman was aged 42, and the hand three months later was as strong as its fellow.

PALMAR ANEURYSM.

The rarity of this disease in arteries so small in size as those of the forearm and hand is well known. Aneurysm when present in the palm is usually the result of injury, or, much more rarely, it is embolic in nature and co-exists with serious disease of the heart.* In a third class of case the aneurysm is an instance of localised subacute endarteritis deformans,† and arises without any known cause. The inner part of the superficial palmar arch is that chiefly affected.

Operation.—If other treatment has failed, if the aneurysm continue to increase, to cause troublesome throbbing, and numbness of the fingers supplied by the ulnar nerve, it is best treated by excision after ligature of the ulnar artery above and below. The skin having been thoroughly cleansed (p. 17), and an Esmarch's bandage applied above, a longitudinal incision, two to three inches long, is made over the swelling, dividing the skin, palmaris brevis, and palmar fascia. Any tendons and the ulnar nerve are carefully drawn aside. The ulnar artery is then tied with sterilised silk above and below the swelling. The sac is next snipped away with scissors, and, if needful, the deep branch of the ulnar artery is tied also. The palmar fascia should be united with a few buried sutures of fine chromic gut, and the skin incision closed with sterilised salmon-gut. Movements of the thumb and index finger should be carefully commenced next day, but the other fingers should be kept quiet for the first week. The wound should have healed in ten days.

While the above course is certainly the best, cases which have been recently recorded‡ show that ligature of the ulnar, or of the ulnar and radial, will be sufficient in palmar aneurysm, if, for any reason, the surgeon prefer to adopt this course.

OPERATIONS FOR UNION OF DIVIDED TENDONS. TENORRAPHY. TENOPLASTY.§

As in the case of divided nerves, **the union of divided tendons** may be **primary** or **secondary**, according as the surgeon is called to the case at once or later.

I always prefer to make the parts thoroughly evascular beforehand with Esmarch's bandages, though this step has been objected to as likely to lead to after-oozing, tension, &c. To meet this, every vessel that can be seen should be carefully secured, the wound thoroughly dried out, and then, after any needful drainage has been provided, and the wound sutured (but not over-closely or tightly), before the Esmarch's bandage is removed the dressings should be applied thickly and uniformly so as to distribute the discharges through as wide a surface as possible, instead of allowing them to come through at one spot. The controlling bandage must be placed sufficiently high up not to interfere with any pressing down of muscular bellies which may be needed in order to bring a retracted central tendon end into view.

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* Mr. Holmes, Royal College of Surgeons Lectures, *Lancet*, Oct. 25, 1873; *Syst. of Surg.*, vol. iii. pp. 29, 102, has called attention to this class of case.

† An instructive case, treated successfully by incision of the sac, with interesting remarks on the pathology and treatment of this disease, is recorded by Dr. J. Griffiths, of Cambridge, *Brit. Med. Journ.*, vol. ii. 1897, p. 646. See also my case, p. 64.

‡ A. Caddy, of Calcutta, *Lancet*, 1896, vol. ii. p. 603. The aneurysm was traumatic, and the patient 33. The radial and ulnar were tied. W. Robertson, of Glasgow, *Brit. Med. Journ.*, 1897, vol. ii. p. 1637. Here there had been no wound, but the palm had been repeatedly knocked in starting some engine gear. The patient was 18. The ulnar artery alone was tied.

§ This term, which has been introduced lately, should be reserved for those cases where tendon-suture is found impossible, and tendon-grafting (p. 38) is employed.

The upper end of the tendon will always give more trouble than is the case with a divided nerve, owing to its greater retraction.

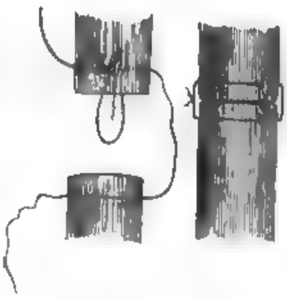
In laying open the sheath to follow up the tendon, most scrupulous care must be taken to use every aseptic precaution, especially in cases where the parts are much disturbed, the sheath extensively opened, &c.; otherwise sepsis may easily be carried far and deeply, if the retracting end has not already done this. Further, it is in the sheath that the vessels run to which we owe the nutrition and repair of the tendon ends.

For the sake of convenience, operations for the union of divided tendons may be classed under the following heads:

A. **Cases where both ends can be found and where they can be easily adjusted.**

A longitudinal incision will usually be best, but in some cases—*e.g.*, where the tendons are matted together—a flap may be preferable. Any bruised, sloughy, or scarred tendon tissue is removed as cleanly and charily as possible. Sutures of thoroughly sterilised silk or kangaroo-tail tendon are preferable to those of chromic gut, which are always liable to give way too soon, especially if suppuration occur. The sutures may be passed and tied (1) *in the ordinary way where the tendon is round, and either of medium or large size.* The silk is passed, on as fine a needle as will carry it, from before backwards through one tendon end, and then from behind forwards through the other, and the ends are knotted on the superficial surface of the tendon. Large tendons may be secured with two lateral or with one central and two lateral sutures, smaller tendons with one median suture only. As the suture is tightened, the ends must be kept in exact apposition with a pointed probe, and not allowed to override one another. In this method and in the others which follow, care must be taken not to insert the sutures too near to the tendon ends—*i.e.*, when there is any tension, not nearer than one-third or even half an inch; finer sutures may then hold the ends exactly together—owing to the muscular tensio and the tendency of the suture to cut through the parallel fascic and their uniting connective tissue.

FIG. 20.



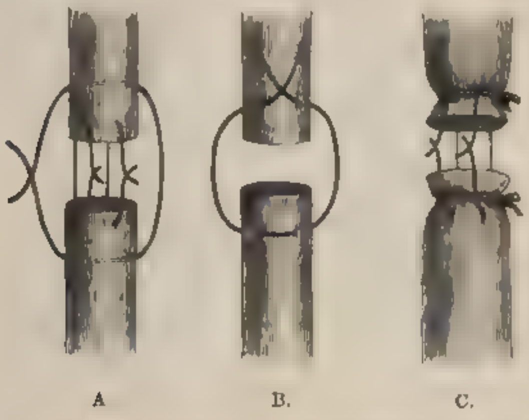
Wölfler's transverse tendon-suture (*Wien. Med. Woch.*, 1888, 5. 1). When the ends touch, the inventor calls his method "direct transverse tendon"-suture, and gives it the name of "indirect" when the ends cannot be brought together, and the threads are tied and left to form guides for the development of fibrous connecting bridges.

Another method which may be employed where the tendon is round and large is that of Wölfler (Fig. 20) or of Trnka (Fig. 27, *b*).

(2) *Where the tendon is flat, e.g.*, on the dorsum of the hand, a very common site for tenorraphy. Here there is much tendency for the suture to cut its way out if inserted in the ordinary manner. One of the following methods—viz., Wölfler's, Le Fort's, Le Dentu's, which are made plain in Figs. 20 and 21—will be found preferable.

(3) *Where the tendon is round and small*, too small for the methods of Wölfler or Le Dentu, and where, owing to the size of the tendon and the traction, a suture inserted in the ordinary way will cut out, that of E. Schwartz may be tried (Fig. 21). A circular ligature of silk is thrown round each of the tendon ends, and two vertical loops passed above and below these ligatures, and thus prevented from slipping, serve to draw the ends together. Circular ligatures thus employed would seem likely to endanger the nutrition of the tendon ends.

Fig. 21.



A. Le Dentu's method of tendon-suture. B. That of Wolfler. C. E. Schwartz's method.
(Le Dentu and Delbet, *Traité de Chir.*, t. iii p. 825.)

In addition to any of the above methods the surgeon may wisely make use of one or more **sutures of support,** *i.e.*, sutures whose object is to relax tension. A suture is made to traverse first one tendon and then the other a full inch or more from the ends, the sheath also being included so as to secure a firm hold, and the ends then knotted in the usual way.

The wound is closed with or without drainage according to its condition, the amount of disturbance, the probable after-collection of blood, &c. The dressings should be applied in sufficient quantity and uniformly so as to distribute any oozing evenly throughout them. If possible, they should be left on for seven or ten days. The limb must be arranged on a splint in such a position that no undue tension falls upon the united tendons, while at the same time the comfort of the patient is attended to. Restlessness, while the anæsthetic is recovered from, must be prevented, as, if the sutures do not hold, the parts will tend to heal in one contracted mass. Most careful attention will be needed afterwards in the employment of carefully begun and perseveringly continued passive and active movements. In commencing movements the surgeon has, on one hand, to prevent the formation of adhesions; on the other, he must remember the risk of breaking down the recently formed union. The date must vary with each case, but, as a rule, in the case of the tendons of the fingers, passive movement may be begun, very gently so as not to strain the union, about the sixth day, and gradually increased. About the twenty-first day will usually be early enough for the commencement of active movements.

In cases of secondary tendon-suture, as in that of nerves, the result may be disappointing for some months; but if the tension was not extreme, and if the wound ran an aseptic course, the final result will probably be satisfactory.

I would take this opportunity of saying that, in the treatment of an incised wound of the hand or foot, the condition of the tendons should be cleared up as well as that of the vessels. The practitioner too often rests satisfied with arresting the urgent hæmorrhage. The wound heals quickly, but loss of power remains. The following is a good instance:—

In August, 1888, H. P., æt. 31, was sent to me with constant flexion of, and inability to extend, the last two phalanges of the thumb. A few months before he had been treated for severe hæmorrhage from an incised wound of the dorsum over the first phalanx and metacarpal bone of the right thumb. By dissection the extensor secundi internodii was seen to be divided, the upper end being found by following up the sheath. The extensor primi had been only partially divided for three-quarters of its width. When trimmed the two ends of the extensor secundi were separated by an interval of an inch on complete extension of the thumb. Use of a stout silk suture, and pushing down the upper end of the tendon, left the ends still separated by a quarter of an inch; two very fine silk sutures brought the ends into good, but not exact, apposition. On hyper-extending the thumb the V-shaped notch in the partially divided extensor primi was obliterated, so no sutures were used here, the edges of the notch being merely refreshed. A splint was applied on the palmar aspect, so as to keep the thumb hyper-extended. Morphia was given at first. When the patient was seen, two months later, he had recovered complete extension.

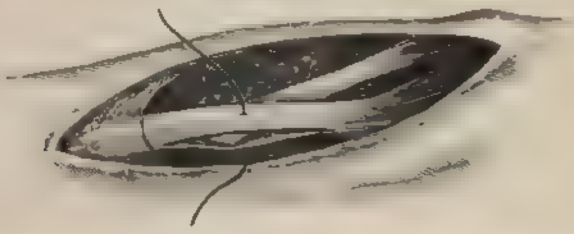
B. Cases where only one end can be found.

The distal or fixed end of the tendon can nearly always be found. To meet the difficulty, often extreme, of finding the retracted upper end of one of the flexor tendons, M. Félizet (*Bull. et Mém. de la Soc. de Chir.*, t. xix. p. 610, 1893) advises, if slitting up the sheath and methodically pressing down the muscular belly are insufficient, that the upper end may be made to emerge into view, and further disturbance of the parts avoided, by extending the adjacent fingers. By this step what M. Félizet terms the little fibro-serous vincula, which tie together adjacent tendons, are drawn upon and pull down the upper end of the severed tendon into view. If, after careful search, sufficient slitting-up of the sheath, &c., it is still impossible to find the upper end, the lower end may be successfully attached to a neighbouring tendon by **tendon-anastomosis.** This is effected (1) by suitably preparing the contiguous lateral margins, (2) by fixing the severed end *in a button-hole* made in an adjacent tendon (Fig. 22).

(3) **Anastomosis by Bifurcation or Splitting of a Tendon.**—Thus M. E. Schwartz, in a case where the proximal ends of two of the extensors of the thumb could not be found, united the peripheral ends to

the extensor carpi radialis longior, which was split longitudinally and in part sutured between them (Fig. 23).

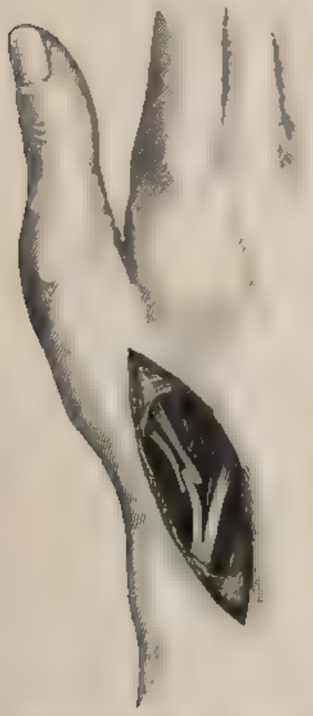
Fig. 22



Button-hole method of tendon-anastomosis. Method of MM. Tillaux and Duplay. Duplay and Reclus, *Traité de Chir.*, t. 1, p. 825.)

The following case (Dr. v. Fillenbaum, *Wien. Med. Woch.*, Nos. 29 and 30, 1885) is a good instance of the success of the last step, and of one means of employing *sutures* so as *to prevent tension:*

Fig. 23



Tendon-anastomosis by splitting or bifurcation of an adjacent one. Method of M. E. Schwartz. (Dentu and Delbet.)

An oblique cut with a bread-knife involved the common extensor of the index and middle finger, and the extensor indicis, the central end of the latter retracting so far that it could not be reached, unless by slitting up its sheath. The tendons of the common extensor were each united by two fine silk sutures.

The accessible peripheral end of the extensor indicis was attached to both ends of the sutured tendon from the extensor communis to the index finger. The strongly stretched extensor tendons of the second and third fingers were now fixed (to prevent retraction by muscular action) by silk sutures passed, 2 cm. higher up, through skin and tendon sheath, and tied over a roll of iodoform gauze. These were removed on the fifth day. Passive movement was begun on the sixteenth day. Six months later the man had perfect use of his fingers.

If it is the proximal end which is alone accessible this must be sutured to an adjacent tendon, the action of which it will reinforce, without regaining its own special function. This must be looked upon as a last resort.

The back of the hand is the "seat of election" for the anastomosis of tendons, as they are here united by fibrous expansions. Thus a neighbouring tendon can be relied upon to render active the peripheral end of another tendon whose central end cannot be found. Furthermore, it is on the back of the hand, and especially near the knuckles, that operations on tendons give the best results. Retraction is less here than elsewhere, owing to the presence of connecting bands and expansions to the joint-capsules; there is less bleeding; the skin is thinner, and its greater mobility renders less harmful the formation of any adhesions.

But while tendon-anastomosis is especially applicable to the extensors, the following shows that it may also be employed in the case of one of the flexors, the tendon of the flexor longus pollicis having been joined with the index tendon of the flexor profundus, with marked success, by Mr. F. T. Paul (*Liverpool Med.-Chir. Journ.*, 1895, p. 500):—

A boy, æt. 7, falling with a cup in his hand, had sustained a severe cut across the ball of the right thumb. There was no power over the last joint, and consequently no power of holding anything—*e.g.*, a pen, in the usual way. An incision over the flexor longus revealed the distal end of the tendon in good condition and firmly attached to the scar. This end having been isolated, the central end was sought for, but, though the incision was prolonged to an inch above the annular ligament, no trace of it could be found. It was quite useless to search higher, since, if found, the tendon would be too short to bring down and attach to the distal end. Under these circumstances Mr. Paul decided to endeavour to obtain a union between the terminal end of the flexor longus pollicis and the side of the index tendon of the flexor profundus; a step which, if successful, would give the patient a power of flexing the thumb and forefinger together, and thus of holding articles between them. The free end of the thumb tendon was cut into a wedge-shape, and inserted into a notch made in the side of the index tendon, where it was retained by two or three very fine sutures. The wound healed by first intention, and a year later it was found that not only had the boy the combined power of grasp hoped for, but that, under training by a skilled pianist, he was obtaining independent movement of the thumb and forefinger. The fact that, while the boy had only one muscle between the two digits, he could yet flex them separately, was entirely due to training of the extensors. Thus, if told to bend the thumb alone, he would fix the forefinger by its extensor, and then flex the thumb, or the reverse.

C. Cases where both ends can be found but it is impossible to adjust them.

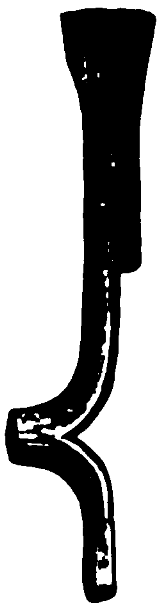
This difficulty is usually met with after the removal of a growth from a tendon, and in some cases of secondary tendon-suture. The following methods are available.

i. Tendon-lengthening.

a. Method of Trnka (*Centr. f. Chir.*, No. 12, 1893) (Fig. 27).—This is most applicable to stout tendons. When this method is employed, the incision must not be carried too near the end of the tendon, and to prevent this being detached by any tension that the strip will be called upon to bear, it will be well to secure it above as well as below by one or more sutures (Fig. 27, *a*).

b. Method of Czerny (Henck, *Centr. f. Chir.*, No. 18, 1882).—Czerny, in a case in which one of the extensors of the thumb had been divided, doubled down a slip of the peripheral end, as shown in Fig. 24. But during this step the slip became entirely detached, and then had to be treated as a true graft. If this method be employed, a suture should be inserted at the angle where the slip is turned down, so as to prevent its being stripped away. The method of Trnka is

FIG. 24.



Tendon-lengthening by Czerny's method. (Dentu and Delbet.)

intended to prevent the accident which is likely to occur in that of Czerny.

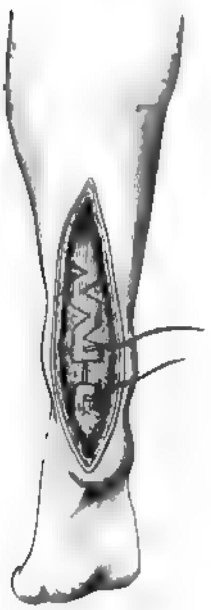
c. Tendon-lengthening by Zig-zag Incisions (Fig. 25).—M. Poncet, of Lyons, has shown (*Gaz. Hebd.*, 1891, p. 575) that this method may be successfully employed in cases where, owing to the tension, the threads which have been inserted in the ends of the tendons threaten to cut through.

In the first case, that of a boy whose tendo Achillis had just been severed, M. Poncet, in order to diminish the tension necessary to bring the ends together, made, on the upper end of the tendon, two cuts in zig-zag fashion, each passing a little more than half across the width of the tendon. Marked elongation of the tendon followed, and it was then easy to suture the ends without tension. The boy was allowed to walk on the twenty-eighth day, and left the hospital about seven weeks after the injury, walking being almost perfect.

While this method is especially applicable to the tendo Achillis from its size, M. Poncet has also used it in the case of the extensor indicis.

In this case also two zig-zag incisions on the upper end of the tendon enabled the suture, which had previously threatened to cut out, to be inserted without any tension.

Fig. 25.



Tendon-lengthening by zig-zag incisions. (Poncet.)

The incisions should pass through at least half the width of the tendon, and include both this and its sheath. There is no risk of the tendon sloughing if antiseptic precautions be taken.

d. Tendon-lengthening by the **Z**-*shaped Method.*—This will be made plain by Fig. 29, p. 45.

e. Tendon-lengthening by means of Osteotomy.—The same M. Poncet, of Lyons (*Revue d'Orthop.*, July, 1891), made use of the following ingenious method in uniting a severed tendo Achillis (Fig. 26):

Forty days after the injury (by an axe) the wound was healed, but the ends of the tendon were 3 cm. apart, and the lameness was very disabling. A **U**-shaped flap having been turned off the back of the heel, a slice of the os calcis was then vertically detached with the saw; when quite loose it was glided upwards, and the lower part of it fixed to the upper part of the sawn surface with an ivory peg. The ends of the tendon could now be brought into close apposition without undue traction. The result was perfect.

ii. **Distance Sutures.**

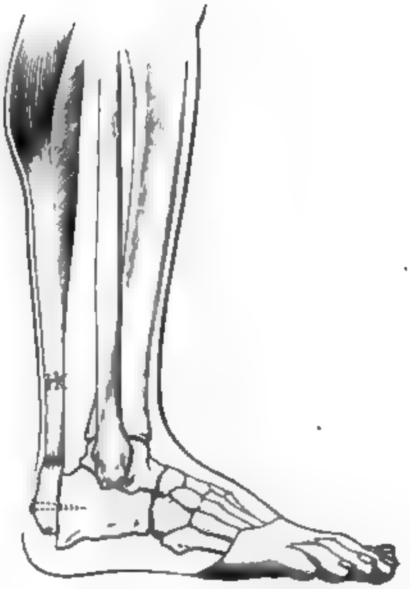
MM. Anger, Forgin, and Assaki were amongst the earliest workers on this subject.

a. Distance Sutures alone.—In some cases (the earliest being one of M. Anger's) where the ends of the tendon could not be adjusted, and suture-loops have been passed and knotted between the widely separated ends, these sutures have appeared to diminish muscular tension on the tendon ends, and to help in directing the reparative process.

This method of **distance-sutures** seems to have been employed in this country as long ago as 1889, by Mr. Gostling, of Worcester (*Lancet*, ii. 1890, p. 767), in a case of injury to the extensors of the thumb.

Eleven weeks before, while the patient was pruning roses, his knife inflicted a wound, the scar of which, an inch long, was found about an inch above the base of the metacarpal bone of the left thumb. Just below this scar the distal ends of the extensor primi and ossis metacarpi pollicis could be easily felt, but the proximal ends could only be indistinctly made out, five inches off, on the back of the forearm. The left hand was of little use, the thumb being flexed and adducted into the palm. An incision exposed the distal ends at once, but the synovial sheath was blocked at the scar for three-quarters of an inch by a mass of connective tissue. This was cut through and the sheath slit up until the proximal ends of the tendon were found. All four ends were smoothly rounded off, and no adhesion had formed. As the ends were five inches apart it was impossible to bring them nearer together than three-quarters of an inch. The ends having been pared, they were stitched together with two catgut sutures each. The wound healed by first intention, and six months later all the movements of the thumb were perfect.

FIG. 26.



Suture of tendo Achillis by partial detachment and sliding upward of the os calcis. Poncet's method.
(Duplay and Reclus.)

In 1886, Wölfler successfully combined the method of *distance-suture* and attaching the ends of the severed tendons to adjacent sound ones.

The patient had had all the tendons of the extensor communis severed. He was unable to extend the middle and ring fingers, but retained this power over the index and little fingers. At the operation, two months after the injury, it was necessary to divide the posterior annular ligament in order to find the central ends of the tendons. As the separated stumps were 8–9 cm. apart, direct union was hopeless. The ends were joined by indirect transverse sutures of silk and catgut, the loops being 8 cm. long. The four central and peripheral tendon ends were also united to the adjacent uninjured tendons, two to the extensor indicis and two to the extensor minimi digiti. Though the wound healed without suppuration, the silk-thread loops were cast off unaltered. Ten days after the operation the patient began to extend his fingers, and he ultimately regained extension of each individually, as in the uninjured hand. This good result must have been due to the fibrous tissue which had been developed in the place of the catgut and silk threads, and not to the joining of the tendons to those which were intact.

M. Glück, who has employed the method of *distance-sutures* with marked success in several cases, used it in one instance, not for filling up a gap in a tendon, but for replacing an end which was lost (*Semaine Médicale*, 1892, p. 198).

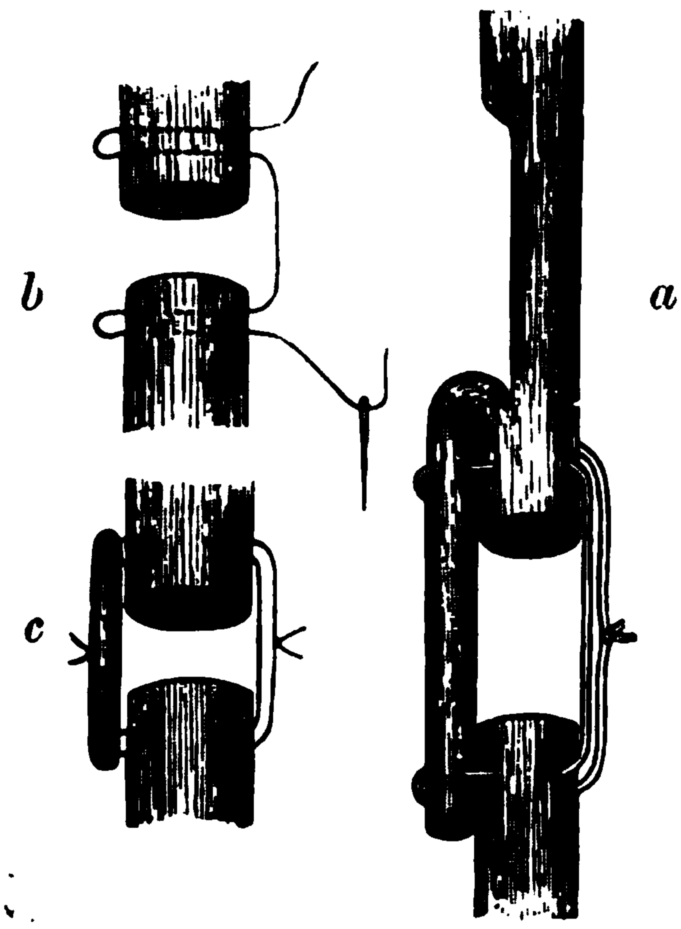
A boy suffered from injury to the tendons of the extensor indicis and communis. M. Glück firmly tied the central ends of the tendons with loops of silk, and carried them forward to their points of insertion, where they were fixed by means of a steel needle.

The first trial failed, the sutures tearing out. A second operation succeeded. When the needle was removed, at the end of four weeks, both the middle and terminal phalanges could be extended.

b. Distance Sutures together with Bundles of Threads of Silk and Catgut (Fig. 27).

In a case in which the two ends of the flexors of the middle finger were widely separated after an injury, M. Glück (*loc. supra cit.*) was able to remedy a gap of 10 cm. (=4 in.) by substitution of threads of silk and catgut. Healing by first intention and perfect restoration of movement followed. It was thought that in this case a gradual substitution of the catgut by connective tissue took place.[*] In other cases the foreign body employed remains long encysted in a sheath of connective tissue. Strict asepsis is, of course, essential.

FIG. 27.



Different methods of tendon-suture. (Trnka.) In the right-hand figure, *a*, where the ends of the tendon cannot be brought together, tendon-lengthening (p. 35) has been employed on one side, and some catgut strands—a form of distance-suture (p. 36)—on the other. In the left-hand figure a form of transverse suture is shown above, *b*; below, *c*, distance-sutures consisting of different thicknesses of catgut have been used.

iii. **Tendon-grafting, properly so called.**

Here a part of another tendon, from the same patient, in cases where there has been an extensive injury, as in a partially crushed hand, or a tendon from the rabbit, is made use of.

Mr. M. Robson (*Clin. Soc. Trans.*, vol. xxii. p. 291) successfully grafted 4½ inches of a flexor tendon from a finger too much smashed to save, on to the dorsum of the hand, so as to form a new extensor for the index finger, the tendon of which had been completely torn away. The proximal end of the tendon was stitched to the fleshy belly of the extensor communis, where the tendon had been previously attached, the distal end being fixed to the small portion of tendon left near its insertion into the phalanx. The case, which is an excellent instance of conservative surgery, ended in recovery with a most useful hand. During extension of the index the new tendon could be felt to move under the skin.

M. Peyrot (*Bull. de la Soc. de Chir.*, 1886, p. 357) transplanted in one case the tendon of a dog, and in another that of a cat, into the gaps between divided tendons in man. A fair amount of flexion was obtained.

It remains to be seen how far this method will supersede that of distance-sutures (p. 36). Such grafts probably act as conductors only in the process of formation of new fibrillæ The method is somewhat troublesome, and can obviously only be practised under limited conditions, and, in the case of tendons from animals, only when the needful preparations can be made.

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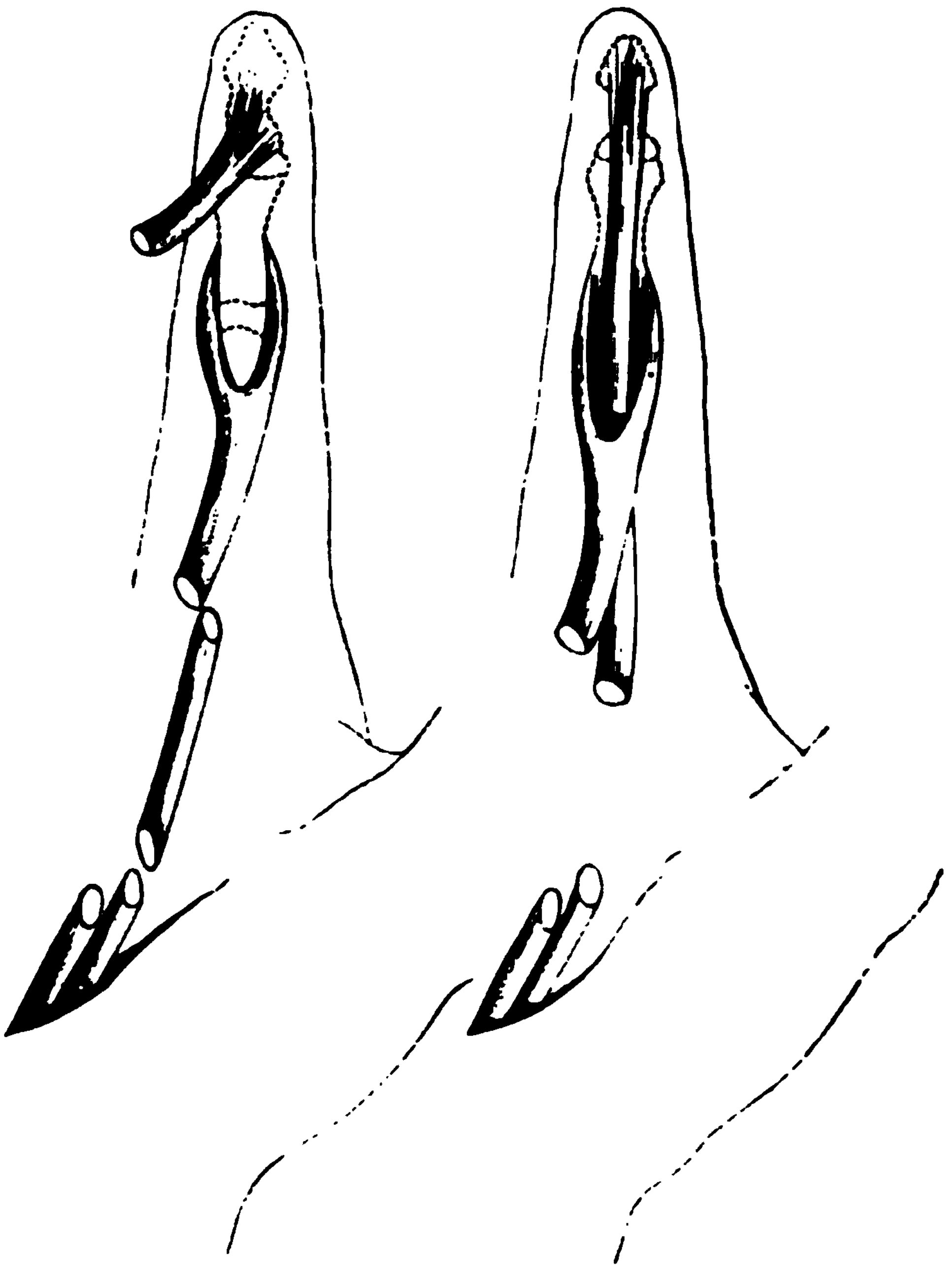
[*] In some cases the sheath may be used to supplement the distance-sutures. After the tendon ends have been mobilised, any remnants of the sheath are dissected free, and so sutured as to help in forming a canal along which the new formation of connective tissue may take place.

Dr. V. Rochet, of Lyons, has published (*Gaz. Hebd.*, 1891, p. 293) a case in which he practised successfully a method of *tendon-grafting*, which he called *autochthonous*, the graft being taken from one of the divided tendons themselves (Fig. 28). This method is especially applicable to the flexor tendons of the fingers.

The patient had, two months before, suffered division of the flexor tendons at the root of his right index. The two lower phalanges were constantly extended, all power of flexion being lost. The parts having been rendered evascular, an incision over the site of injury showed that an interval of 6 cm. existed between the cut ends of the flexor tendons, and that by no means could this distance be reduced to less than 2 cm. To fill this gap, Dr. Rochet made an incision over the lower part of the middle phalanx and the base of the last, just where the flexor profundus emerges from between the two slips of the sublimis. He divided the former, and then, returning to his first wound, drew the piece of the flexor profundus, which was now cut above and below, out into the first wound, the attachments of the tendon to the sheath yielding readily. The lower end of this tendon-slip was then sutured to the lower end of the flexor sublimis, and its upper end to the muscular ends of the flexor sublimis and profundus—directly to the former tendon, and laterally to the latter. Lastly, the small slip of flexor profundus, which had been left attached to the last phalanx, was sutured to the two slips of the flexor sublimis a little above its insertion into the second phalanx. The wound healed quickly, and on the fifteenth day some power of flexion was already present. Later on the second phalanx could be flexed as freely as its fellow. Flexion of the third phalanx was more limited, this not passing beyond a very obtuse angle.

FIG. 28.



Autochthonous tendon-grafting. (Rochet.) To the right is seen the gap between the tendons found on exploration; to the left the manner in which it was filled up.

Dr. Rochet observes that it would be possible to carry out the above method by taking the graft or slip from the upper end of one of the lower parts of the divided tendons without interfering with its insertion, which involves making a fresh wound.

M. Desquin (*Belg. Méd.*, Dec. 24, 1896; *Epit. Brit. Med. Jour.*, Jan. 23, 1897) has devised another method of tendon-grafting, by which the use of a finger flexor was restored.

A carpenter, æt. 25, had the right middle finger in permanent extension, owing to the severance of the flexor tendons by broken glass. The man came to M. Desquin, thirteen months later, seeking amputation. A very free incision having been made along the course of the tendons in the finger and in the palm, it was found that 4 to 5 cm. of the superficial tendon were wanting. It was impossible to find the deep tendon.* By strong traction on the central end of the superficial tendon, seized in the palm, it could be brought in contact with, and sutured to, the phalangeal end. This could only be done by strongly flexing the finger, and it would have been impossible to unite the superficial parts over the strongly stretched tendon. Returning to the wrist, therefore, the operator divided the tendon with a small piece of muscle adhering. The finger was then extended and the tendon just divided stitched to that for the index finger, so that the flexor for the latter, on its contraction, acted upon both fingers. The result was perfect. After four weeks the fingers could all be flexed simultaneously, or the index and middle together, the others remaining extended.

The following instance of tendon-grafting as a substitute for amputation, in cases where suppurative tenosynovitis or deep whitlow has destroyed the tendons, is recorded (*loc. supra cit.*) by the same author:

The patient, æt. 19, could not flex his right index finger owing to destruction of the flexor tendon by a deep whitlow. Some weeks after the healing of this, an incision was carried from the pulp of the index finger along the normal course of the tendons to just above the wrist-joint. In the palm the fascia was divided, and above the annular ligament the common flexor sheaths were opened. The search for the tendon ends proved easy below, where a few tags remained adherent to the phalanx, but difficult at the wrist. At length one was found which wanted 10 cm. of its length. To supply the gap an equivalent of the superficial flexor was taken. This was severed near its origin, and drawn down strongly until it could be sutured peripherally. The upper end of its lower segment was then stitched to the lower end of the deficient deep flexor. Despite some suppuration and the exposure of the transplanted tendon, for a week, over a small distance in the first phalanx, where the incision had divided purely cicatricial tissue, no exfoliation followed. Two years later, flexion of the finger was performed as freely and strongly as in the others.

Resection of Bone in aid of Tendon-suture.—It will suffice merely to allude to this method, which can only rarely be justifiable. K. Lobker (*Centr. f. Chir.*, 1884, No. 50) seems to have been the first to make use of it. In a case of long-standing division of the tendons above the wrist, portions of the radius and ulna were resected. The result was only a partial success, and the bones took three months to unite firmly. It is, however, only fair to remember the date of this case, which was before the era of strict antiseptic surgery.

Tendon-transplantation has of late years been made use of **in infantile paralysis,** the object being to reinforce a paralysed or paretic muscle by attaching to it one or more tendons of adjacent healthy muscles. This method deserves an extended trial, owing to the great frequency of infantile paralysis in our large towns; the crippling which it involves; the expense otherwise entailed by mechanical treatment, extending, as this usually does, over a lifetime (R. Jones); the limited amount of good which other operations, *e.g.*, tenotomy, usually effect; and the fact that transplanting of tendons, of itself not a severe operation, can be employed early in life, when the muscles on which the additional work is placed have still natural growth to make, and at the same time the paralysed muscles have not had time to undergo those secondary changes which are so baffling to the surgeon.

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* No explanation is given of this and the above-mentioned gap in the superficial tendon. The original wound had healed by first intention.

As long ago as 1882, Nicoladoni (*Arch. f. klin. Chir.*, Bd. xxvii. S. 660) recorded a case of paralytic talipes calcaneus in which he attached both peronei to the tendo Achillis with a good result. Drobnik, of Posen, published, in 1892 (*Zeit. f. Chir.*, Bd. xliii. S. 473), the first series of cases, sixteen in all. Mr. Eve has published (*Brit. Med. Journ.*, vol. ii. 1898, p. 1140) three cases of infantile paralysis in which he transplanted tendons.

In Case 1 the child was aged 6½ years, and the left foot was in a position of extreme equino-varus as the result of infantile paralysis of the peronei, which did not react in the slightest degree to faradism. The extensor l. digitorum only reacted slightly. The tendon of the tibialis anticus was divided and attached to the peroneus brevis, and the tibialis posticus tendon after division was carried above the internal malleolus and attached to the extensor l. digitorum. The child developed scarlet fever, and had to be discharged from the hospital in a plaster-of-Paris splint, about a month after the operation. About three months later the tendo Achillis was lengthened by the Z method (Fig. 29). Six months later, Oct. 1898, it is reported that the child walked fairly well with the foot flat on the ground; there was good power of dorsi-flexion, and no adduction.

In Case 2 the extensor l. digitorum was paralysed together with the tibialis anticus. Here the tibialis posticus was divided at its insertion and attached to the anticus, while, to reinforce the power of dorsi-flexion, the peroneus brevis was attached to the extensor l. digitorum. By a subsequent operation the tendo Achillis was lengthened. The result was good, the foot being braced up at a right angle, and the boy, æt. 11, walking firmly upon it.

In Mr. Eve's third case the child was 2½, and had foot-drop and eversion from infantile paralysis. The child walked on the inner side of the foot; the peronei acted well. Inversion was completely lost. Here the peroneus longus was attached to the extensor l. digitorum, and the peroneus brevis to the tibialis anticus. About six months later there was distinct voluntary power of dorsi-flexion, no eversion, the foot was in fairly good position, but the results of osteotomy for a co-existing genu valgum must be waited for before the full benefits of the above tendon-transplanting can be justly expected.

Dr. Milliken (*New York Med. Record*, Nov. 28, 1896) has operated fourteen times on nine patients, the operations falling into the following eight varieties:—(1) Transplantation of the sartorius into the sheath of the paralysed quadriceps extensor; (2) Grafting of extensor proprius hallucis to tibialis anticus. (3) Extensor longus digitorum to tibialis anticus. (4) Tibialis anticus to extensor longus digitorum. (5) Extensor proprius hallucis to extensor longus digitorum. (6) Gastrocnemii to peronei. (7) Transplantation of flexor longus hallucis to the front of the leg and attachment of it to tibialis anticus. (8) Graft from deltoid attached to the tendon of paralysed triceps. The results were very encouraging, failure to obtain union only occurring in one case.

Operation.—Where the two tendons to be operated on lie close together, an oblique incision of adequate length will suffice. But where the two tendons lie farther apart, Mr. Eve points out that the necessary extensive division of veins leads to œdema of the foot. He has thus adopted a different plan. "The insertion of the tendon to be transplanted (*e.g.*, the tibialis posticus) was exposed by a small incision, and the tendon divided. Then a similar incision was made over the tendon of the same muscle (just above the internal malleolus), and the divided tendon was pulled through it. Next, supposing that it was intended to attach it to the tibialis anticus, this tendon was exposed just below the front of the ankle by a similar incision. The skin and fascia intervening between this last incision and that through which the tibialis posticus tendon protruded above the internal malleolus was tunnelled under by means of scissors. The free end of the tibialis posticus was pulled through this tunnel, and attached to the tendon of the tibialis anticus, the foot having been first placed in the position desired. The tibialis posticus would be attached to the anticus in such a state of tension as to retain the foot in the improved position." The method employed of uniting the tendons was that of M. Tillaux (Fig. 22). As the tendon of the paralysed muscle is always atrophied and slender, Mr. Eve advises that it should not be split or divided. Dr. Milliken advises the use of kangaroo-tendon sutures and plaster-of-Paris splints.

Dr. E. H. Bradford, Surgeon to the Children's Hospital at Boston, in a paper on "Tenoplastic Surgery" (*Ann. of Surg.*, Aug. 1897), thus describes transplantation of the peroneus longus in suitable cases of infantile paralysis, *e.g.*, in talipes valgus, that it may in part take the place of the weakened tibials. An incision is made between the outer malleolus and the tendo Achillis. The sheath of the tendon is opened slightly above the level of the malleolus, and the tendon gently pulled from its sheath and cut across. The cut end is pulled out of the sheath, and enough of the tendon freed to leave an end of at least two inches in a foot of moderate size. The wound having been next opened out by blunt hooks, an opening is made between the tendo Achillis and the tibia, and gradually dilated until the tendon can be passed through. An incision is then made on the inner side in the region of the tibialis posticus tendon. This paralysed tendon, when found, is divided close to its insertion, the cut peroneal tendon passed through the opening beneath the tendo Achillis, and the cut surfaces of the two tendons firmly sewn together. Where the gastrocnemius needs reinforcing, the cut peroneal tendon is passed through a slit made in the widest part of the tendo Achillis. Dr. Bradford recommends that the inserted tendon should be here stitched by interrupted sutures as it enters the tendo Achillis and as it emerges from the other side; the projecting end can be folded along the edge and stitched to give greater strength.

Transplantation of the sartorius is thus described by the same writer. An incision is made on the inner side of the thigh, from the internal condyle upwards in the direction of the insertion of the adductor magnus tendon. The limb is flexed at the knee and abducted. Some difficulty is frequently met with in finding the sartorius, which in a paralysed limb falls more towards the inner side than is normal. The muscle will be recognised by the length and direction of its fibres. It should be followed well down to its insertion, and cut across at the level of the internal condyle or slightly below it. The skin incision is then drawn to the outer side, and the conjoined insertion of the and vastus internus found. The divided sartorius is inserted under this, and sutured firmly to it, not only at its cut end, but laterally as well. After the operation the limb should be fixed in a straight position.

That excellent authority on orthopædic surgery, Mr. Robert Jones, of Liverpool, has discussed with Mr. Tubby the conditions needful for successful tendon-grafting and transplantation in infantile paralysis (*Medical Annual*, 1899, and *Liverpool Med.-Chir. Rev.*, 1899, p. 270). The following are the details urged:—"(*a*) The muscles should be carefully tested, and the relative strength of each determined. (*b*) All conditions due to contraction of the plantar fascia, such as pes cavus, should be previously removed by operation. (*c*) The operation is rarely called for when one muscle only is partially paralysed. (*d*) Cases in which all the muscles are paralysed and a flail-like joint exists are not suitable for tendon-grafting. For such cases arthrodesis should be reserved (*q.v.*). In selecting a healthy muscle for reinforcing a paralysed one, it is advisable, but not essential, that the one selected should belong to the same group as the paralysed one. The advantages are that it is nearest—restoration of a voluntary function is thus more quickly secured. If it be practicable to obtain a reinforcing muscle from the same group, the selection should be made from a muscle the line of which is most nearly coincident with that of the paralysed muscle. For instance, in reinforcing the tendo Achillis for talipes calcaneus the peroneus longus and brevis may be used. In reinforcing the tibialis anticus for paralytic valgus, either the extensor proprius pollicis or part of the extensor communis digitorum will avail. The reinforcing tendon should be carried as direct as possible to the paralysed muscle, and not bent at an angle, which would have the effect of considerably lessening the transfer of power. For instance, if the peroneus brevis were used to reinforce the extensor communis digitorum, it should be attached above the ankle, and not in front of the malleolus.

"The operation which has yielded the best results in the treatment of talipes calcaneus has been that of grafting the peroneus longus and brevis to the tendo Achillis. The value of this operation lies in the fact that almost all attempts to shorten an unduly lengthened tendo Achillis result in failure, except by this new method of grafting. Cases of paralytic valgus, due to paralysis of the tibialis anticus and posticus, may be treated in one of the following ways:—The tendon of the extensor proprius pollicis may be split, and part of it attached to the anticus. Similarly, a piece of the flexor longus digitorum may be attached to the tibialis anticus. Or, in place of the latter, a strip may be slit off from the tendo Achillis, with muscular fibres of the gastrocnemius attached, and used to reinforce the posticus. Or, still further. the peroneus longus may be brought across the front of the extensor tendon sheaths and stitched to the anticus. The employment of the peroneus longus in this connection emphasises an important point, that by selecting one of the opponents of a paralysed muscle we not only reinforce that muscle. but we weaken the antagonism which exists between the two groups, since by transferring, as in this case, the insertion of the peroneus longus from the outer to the inner border of the foot, we te[illegible]lise the forces acting upon those two borders. Cases of par[illegible] to paralysis of the peronei may be treated in the following way :—The peroneus longus tendon may be reinforced by a strip of the tendo Achillis, and the brevis by a strip from the tertius, or one of the outermost parts of the extensor communis. In the compound forms of paralysis considerable ingenuity can be exercised in determining which muscles shall be used as the graft. Taking a case of paralytic calcaneo-valgus, the peroneus longus may be used to reinforce the tendo Achillis, and a strip of the extensor proprius pollicis to reinforce the tibialis anticus, and a strip of the flexor longus digitorum to reinforce the tibialis posticus. In paralytic equino-varus, Tubby has adopted the following plan: A long incision is made on the posterior aspect of the leg and at its outer part. The tendo Achillis is split lengthwise as far as the point where the two heads of the gastrocnemius meet. The outer strip so made is attached to the distal part of the divided peroneus longus, and the remaining portion of the tendo Achillis is divided with a tenotome. The foot comes at once into position, and the result is extremely good." The following points are also insisted upon :—The operation must be absolutely aseptic. The sheaths of the tendons operated upon must be opened up sufficiently freely to allow of the reinforcing tendon being applied easily to the paralysed one. The reinforcing tendon may either be passed through the paralysed one, and attached to either of its surfaces, or alongside it. Silk freshly and properly sterilised is the best uniting medium. The proximal part of the reinforcing tendon should be pulled quite tight, and united to the tendon of the paralysed one at such a spot that the former, when it is fixed, is at its utmost possible tension. After the operation, the limb is put up in the position in which it is decided it should remain subsequently.

Tendon-lengthening. — Several methods have been given of lengthening the ends of divided tendons. I now refer to a method of lengthening entire but shortened tendons which may be useful in some cases of contraction of joints owing to lesions in the muscles which act on them—lesions, it may be added, which are unaccompanied by any paralysis or spastic changes. Such cases are occasionally met with in contraction of the fingers following inflammatory matting of the muscles, prolonged immobilisation of the forearm in splints, and the like.*

In the lengthening of contracted tendons, *e.g.*, of the fingers, there should be no paralytic complication from disease of the nervous system present—conditions which would interfere with a successful after-result, however carefully the tendons are lengthened and sutured. Again, for the success of this method the tendons operated on must be healthy, or at least free from much inflammatory matting, a condition which will prove obstinately recurrent, while the manipulations needful to free the tendons at the time of the operation are very likely to produce sloughing.

I have only space to allude to another small group of cases in which tendon-lengthening may sometimes be useful. I refer to infantile spastic paraplegia and some cases of contraction of the flexors of the fingers. In infantile spastic paraplegia it may be employed in some cases of contraction of the adductors, the gastrocnemii, and the flexors of the ankles and toes. The object is to remove some contraction or constant spasm which prevents other measures, such as massage, electricity, &c., being tried. The cases chosen should be early ones in which no great structural change has taken place, and there should be no mental deficiency which will interfere with the intelligent carrying out of directions.

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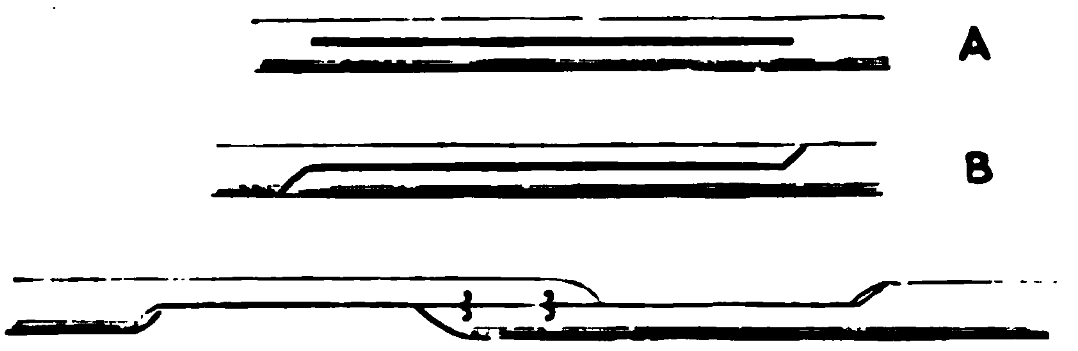
* My readers will obtain information on this class of case in the Hunterian Lectures by Mr. W. Anderson on "Contraction of the Fingers and Toes, their Varieties, Pathology, and Treatment" (*Lancet*, vol. ii. 1891).

FIG. 29.



One method of tendon-lengthening. A. Tendon split longitudinally. B. Section completed by incisions at ends of fissure. C. Divided tendon elongated and sutured. (Anderson.)

Where the tendon is fairly thick and rounded, the following method of tendon-lengthening of Mr. Anderson's may be made use of: In flat and easily frayed-out tendons sloughing would probably follow on so much manipulation of each end. The gap that remains between the two ends of the tendon having been carefully measured, each tendon is split accurately in the middle line, care being taken not to bring the split too near to the end of the tendon. At the two ends of the above incision section of the opposite halves of the tendon is made, as in Fig. 29.

Tendon-shortening.—This may be occasionally called for in some cases of acquired talipes calcaneus, where the tendo Achillis is elongated. As these cases usually date to infantile paralysis it will be well to bear in mind the advice given by Mr. Walsham (Walsham and Hughes, *The Deformities of the Human Foot*, p. 380): "Shortening of the Achilles tendon is only of service when some muscular tissue remains in the gastrocnemius and soleus. When these muscles are completely paralysed and have undergone fatty degeneration, the shortening of the tendo Achillis is useless. At the time of operation, and for some time subsequently, the foot is held in better position; but as soon as the patient begins to walk, the fatty muscle gradually yields, and the condition of the muscle is soon as bad as before the operation. Prior, therefore, to undertaking the shortening of the tendo Achillis, a very careful examination of the electrical condition of the calf-muscles should be made, and if it is clear that complete degeneration has taken place, no operation should be undertaken.* Conversely, if the electrical examination shows that there is some healthy muscle tissue left, it is well to postpone the shortening of the tendon till as much good as possible has been obtained by a systematic course of electrical treat-

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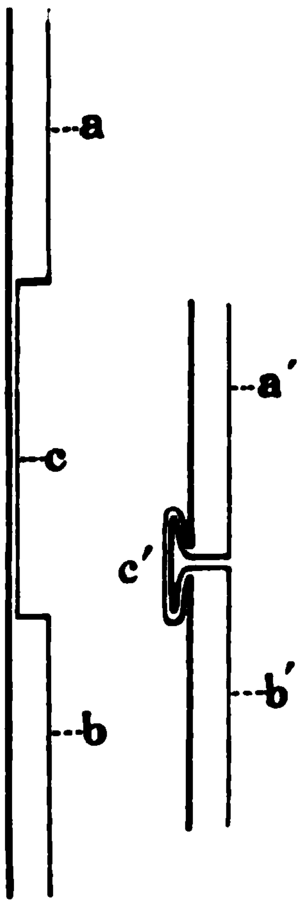
ly operative steps advisable here will be transplantation of a healthy tendon ment, combined with massage of the calf-muscles.” In suitable cases the tendo Achillis may be shortened by one of the following methods.

(1) **Willet's Method** (*St. Bartholomew's Hospital Reports*, vol. xvi. p. 309).—“ A Y-shaped incision, some two inches in length, is made over the lower end of the tendo Achillis down to the tendon. At the lower or vertical point of the incision the dissection is continued until the tendon is fully exposed over its superficial and lateral surfaces for the space of one inch in length, its deep connections being left undisturbed. The tendon is now cut across at the point of junction of the oblique portion of the wound with the vertical. Next the proximal portion of the tendon is raised, with its superficial connections to the integument undisturbed, to the extent of fully three-quarters of an inch, by dissecting along its deeper surface, *i.e.*, by reversing the dissection made upon the distal segment. A wedge-shaped slice of the tendon is now cut off from both segments, that from the proximal being removed from the deep surface, whilst from the distal it is taken from the superficial; in both instances the face of the wedge-shaped portion removed being at the point where the tendon has been divided. The heel being now pressed upwards, the proximal portion, including both skin and tendon, is drawn down and placed over the distal, thus bringing the prepared cut surfaces of the tendon into apposition. In this position they are held by an assistant whilst four sutures, two on either side, are passed deeply through the integument, then through both portions of the tendon, and again out through the integument, and fastened. When the operation is completed, the united edges of the wound assume a V-shaped appearance, owing to the angle of the proximal portion being now attached to the terminal point of the distal portion of the original incision.”

FIG. 30.



Mr. Willet believes the method of merely removing a piece of the tendon and suturing the divided ends to be faulty. The cicatricial tissue filling up the gap will, he says, be merely fibrous tissue, and not homogeneous in structure with the tendon, and, therefore, likely to yield.

(2) **M. Ollier's Method of Tendon-shortening without interrupting its Continuity** (*Traité des Résections*, t. ii. p. 473).—When the tendon is large he removes with a very small bistoury the central part. A window having been thus made, the upper and lower ends are brought together with sutures, and the lateral bands folding upon either side contribute to the joining of the two ends.

Where the tendon is narrow, instead of making a window, M. Ollier adopts the plan shown in Fig. 30.

CHAPTER II.

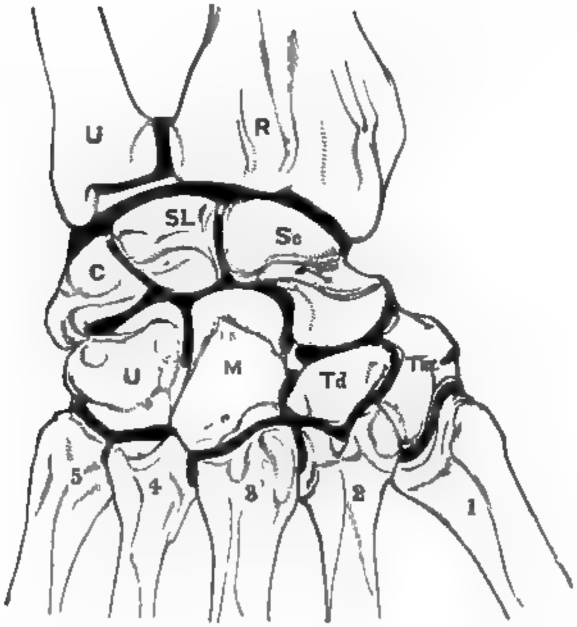
OPERATIONS ON THE WRIST.

EXCISION OF THE WRIST-JOINT (Figs. 31 to 35).

THE reasons for this operation often failing, and the conditions needful for success, may be first considered.

1. Whether the tubercular disease begins in the synovial membrane or in the bones, it extends rapidly, not only to the wrist-joint, but to the two rows of carpal bones and the bases of the metacarpals, along the complicated synovial membranes,* which bring all these bones into

FIG. 31.



The bones and the seven synovial sacs which enter into joints about the wrist. The seventh, that between the cuneiform and pisiform, is not shown. (Mac Cormac.)

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* The arrangement of these, five in number, must be remembered, and their close vicinity to each other. (1) The membrana sacciformis of the inferior radio-ulnar articulation, passing from the lower end of the ulna to the sigmoid cavity of the radius, and lining the upper surface of the triangular fibro-cartilage. (2) That of the wrist-

ment, combined with massage of the calf-musc
the tendo Achillis may be shortened by one of th
(1) **Willet's Method** (*St. Bartholomew's Hos*
309).—" A Y-shaped incision, some two inches in
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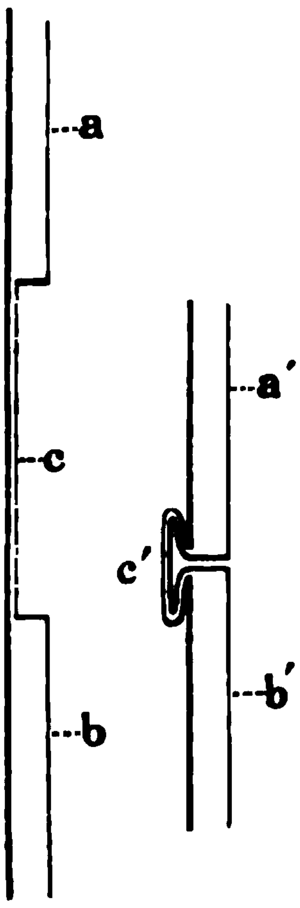
Fig. 30.



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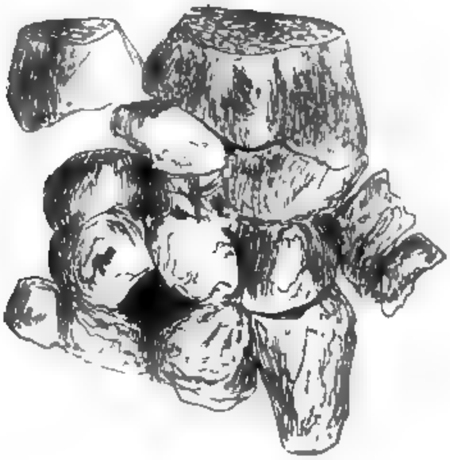
fingers swollen and stiff:—owing to the complicated and
tion required; and, lastly, owing to the impossibility of
any really helpful extent this operation on the dead body:
oing reasons excision of the wrist has not found the favour
sh surgeons which it deserves.

of the above disadvantages and difficulties it is much to be
that, as no less than the saving of hand and fingers is at stake,
eration should, with the advantages of modern surgery, be perse-
with, and that all cases, whatever the result, be fully published.

FIG. 33



Parts removed in excision of the wrist. (Lister.)

I have described two methods only. Excision of the wrist is not a common operation; it must be a difficult one; and the operating surgeon will do well to make himself familiar with, and to practise, one method. The two methods given below bear the names of surgeons who are authorities on the subject—(1) Lord Lister's, introduced to the profession as long ago as 1865; (2) that of M. Ollier, the well-known surgeon of Lyons, whose name stands second to none as an authority on excision of joints, and who has done more than any other surgeon to place excision of the wrist on a sound basis. I recommend the second method as the less complicated of the two, but it is right I should add that only one case (given at p. 57) has come under my care. In young children, owing to the weakness of the ligamentous and other fib

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fingers: (4 and 5) The flexors and extensors of the wrist. Now, the incisions a
so planned as to save absolutely the whole of the first three groups and to div
the tendons of the wrist proper, and these are cut so close to their insertions t
rule, they form new attachments, and resume their functions as recovery takes p
have referred to the question of how far division of any tendons is necessar
(footnote, p. 52).

single structures, the single longitudinal dorsal incision of von Langenbeck or Boeckel—for they are practically the same—may suffice.[*]

(1) **Lord Lister's Operation** (Figs. 32, 33)—An anæsthetic having been given, and the parts rendered bloodless by an Esmarch's bandage,[†] any adhesions of the tendons are thoroughly broken down. The hand should rest on a sand-pillow. The surgeon should be seated. The radial incision is then made, as in Fig. 32. This incision is planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed towards the inner side of the metacarpo-phalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little further out. These directions will be found to serve, however much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by the thumb-nail, and raised, together with that of the extensor brevior, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting-forceps applied in a line with the longitudinal part of the incision, great care being taken of the radial artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected out without much difficulty, whereas its intimate relations with the artery and neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering

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[*] My old friend G. A. Wright, of Manchester, has made use of a similar incision (*Abstract of Med. and Surg. Cases treated at the Pendlebury Hospital*, 1884, p. 133). In a child of 9, with phlyctenular ophthalmia, enlarged glands, and many marks of "strumous" disease, the right wrist was disorganised. "A single longitudinal incision for three or four inches was made between extensor communis and extensor secundi the carpal joints opened, and the bones easily shelled out, the ends of the metacarpal bones and of the radius and ulna were removed with a gouge; one vessel was twisted; no tendon was divided, except in the sense of turning back the extensors of the carpus from their attachments. Six months later, the hand, which before the operation was bulbous, flabby, and useless, was all but healed, and had well shrunken, there was excellent power and mobility." In 1877 I removed five of the carpal bones by a single dorsal incision in an infant, aged 2½ years, a patient of Dr. T. Eastes, of Folkestone, the sinuses present being thoroughly scraped out with a sharp spoon. The result was most satisfactory, both as to the permanency of the cure and the usefulness of the fingers.

[†] Mr. Treves objects to this step, as the oozing which follows the removal of the bandage is usually very considerable and, in his opinion, a great obstacle to healing. I have advised the use of the bandage because, at the time, it is most important not to have the field of the wound constantly flooded by the small vessels of the very vascular parts, this hæmorrhage imperilling the tendons, rendering the operation still more tedious by its interference with the exact carrying out of every detail which is so essential whichever method is selected. Any harm which may accrue from excessive oozing may, I think, be met, as after excision of the knee, by providing adequate drainage, using very few sutures, and enveloping the field of the wound in very ample dressings, through which the discharge shall be uniformly distributed.

the knife at least two inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect. The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger extensors are then separated from the carpus, and the dorsal and internal lateral ligments of the wrist-joint divided, but the connections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pisiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones, for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist-joint is also divided, after which the junction between carpus and metacarpus is severed with cutting pliers, and the carpus is extracted from the ulnar incision with sequestrum-forceps, any ligamentous connections being touched with the knife. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh ossific deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundi internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with forceps applied longitudinally.

If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.*

The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of its metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

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* As an instance of what may be taken away, in one case Lord Lister not only removed the base of the third metacarpal bone, but drilled its shaft into a hollow tube, a sound and most useful hand being retained.

Lastly, the articular surface of the pisiform is clipped off, the rest being left if sound, as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But if there is any suspicion as to its soundness, it should be dissected out altogether; and the same applies to the process of the unciform.

The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes.* Only one or two small vessels require ligature. Free drainage must be given. The hand and forearm are put up on the well-known splint of Lord Lister, with the cork support for the hand, which helps to secure the principal object in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the full extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down the adhesions under chloroform (p. 50) is maintained.

Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the forearm to the knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the forearm.†

(2) **M. Ollier's Operation**‡ (Fig. 34) (*Traité des Résections*, 1888, t. ii. p. 448).—No surgeon speaks with greater weight on excision of the wrist than the celebrated surgeon of Lyons; none have had so much operative experience, and no one has worked so hard in order to bring the operation into better favour, and to insist on the necessity of attention to minuteness of detail both during the performance of the operation and in the after-treatment. Finally, M. Ollier has not only

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* If any of the tendons are unavoidably so interfered with that a portion is likely to slough, it would be well to cut out this part, and unite the ends with a carbolised silk suture. And where much manipulation of a tendon is unavoidable, it would be better to divide it, and unite it subsequently.

† Later on, when this is discarded, if the hand remains weak, I have found it useful to give support on a smaller scale by means of a leather wristlet.

‡ M. Ollier claims that by his method, which must be, as far as possible, subperiosteal (p. 55), not one attachment of the tendons need be lost. By other methods the attachments of the extensors of the carpus, those of the flexor carpi ulnaris and radialis, and perhaps that of the supinator longus, are, he maintains, usually sacrificed.

had unrivalled experience in the excision of this joint, but he has repeatedly, either himself or by his pupils, placed his results before the profession.*

M. Ollier, having tried several different incisions, recommends the following. At first sight the number (three) appears complicated, but it will be remembered that the third—that over the radial styloid process—is merely for drainage.

The parts having been made evascular with Esmarch's bandages, and all adhesions broken down, the hand is supported, extended and pronated, by a sand-pillow.

First Stage: Incision of Skin and Ligaments.—The surgeon, comfortably seated, makes the first and chief incision, metacarpo-radio-dorsal, starting from a point in the centre of a line drawn between the two styloid processes, and running downwards, at first vertically and then somewhat obliquely outwards along the outer side of the extensor indicis, and ending below over the second metacarpal bone at the junction of its upper two and lower thirds. A subcutaneous branch of the radial nerve having been, if possible, avoided, the incision is carried down to the periosteum and dorsal ligaments, great care being taken not to injure the extensor indicis and the extensor carpi radialis brevior. The extensor indicis is first recognised, but its sheath should not be opened as the incision is deepened. It should be drawn aside with a blunt hook so as to expose the tendon of the extensor carpi radialis brevior, the insertion of which it conceals. The periosteum over the base of the third metacarpal is next incised so as to admit of the detachment of the last-mentioned extensor, together with its periosteal sheath, which constitute the radial lip of the deeper part of the wound. The incision is then prolonged upwards along the forearm according to the amount of bone to be removed, and over the annular ligament outside the partition common to the extensor indicis and communis. A little higher up the incision passes between the extensor indicis and the extensor secundi internodii, these tendons being drawn respectively inwards and outwards. In the highest part of the incision the periosteum over the lower end of the radius should be divided. This incision should be four inches or more in length, so as to avoid needless bruising of the soft parts, and to give adequate access to the disease. The ulnar incision is next made, starting about one inch above the styloid process of the ulna, and ending below over the base of the fifth metacarpal bone, the incision being kept rather towards the palmar surface so as to leave the tendon of the extensor carpi ulnaris above in the dorsal lip of the wound. The incision should be made carefully so as not to injure a filament of the ulnar nerve which crosses it, and thus not compromise the sensibility of the little finger. The incision is deepened down to the cuneiform and unciform. A third incision, for drainage only, is made about an inch long over the styloid process of the radius. It should be made now, before the landmarks have disappeared.

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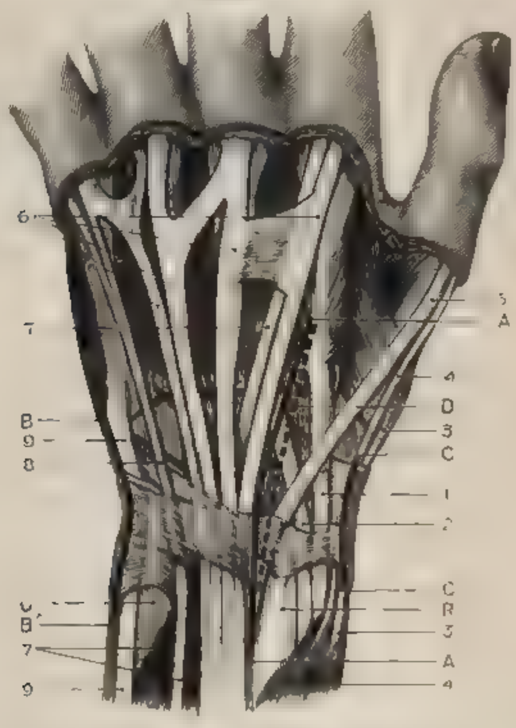
* M. Ollier himself, *loc. supra cit.; Congrès Franç. de Chir.*, 1894, p. 872; and *Résections des grandes Articulations*, 1895. M. Gangolphe, "Tumeur blanche du Poignet," *Tr. de Chir.*, Dentu et Delbet, 1896, t. iii. p. 595; Dr. Mondan, "La Tuberculose du Poignet," *Rev. de Chir.*, 1896, p. 186.

Second Stage: Removal of the Bones. This is facilitated by division of the posterior annular ligament, which allows of easy separation of the tendons. The radio-carpal joint having been opened, the periosteal and ligamentous connections of the carpus are gradually divided, and, the carpus having been made to project more and more above, the flexor tendons are safely detached and held aside in front. It does not matter which of the carpal bones is taken first, whether those that lie beneath the radio-dorsal or the ulnar incisions; as soon as one is removed the extraction of the others becomes easier. The great aim of the surgeon is to remove each diseased bone completely. Being very friable they are easily crushed, and any diseased part that is left adherent is liable to cause tedious suppuration. Each bone should be turned out of its periosteal and ligamentous adhesions with such a periosteal elevator as that shown in Fig. 52, or with blunt-pointed scissors, or gently seized with small forceps and any adhesions carefully divided. The pisiform usually, and often the trapezium,* may be left, and the unciform process of the

FIG. 34



The tendons concerned in excision of the wrist.

A A, B B, C C, The three incisions usually employed by M. Ollier. D, The incision of Boeckel, sometimes described as Langenbeck's, the two being practically identical. R, Radius. U, Ulna. 1 and 2, Radial extensors of the carpus. 3, Extensor ossis metacarpi pollicis. 4, Extensor primi internodii. 5, Extensor secundi internodii. 6, Extensor communis. 7, Extensor indicis. 8, Extensor minimi digiti. 9, Extensor carpi ulnaris. (Ollier.)

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* If the trapezium require removal, the close contiguity of the radial artery and of the flexor carpi radialis must be remembered.

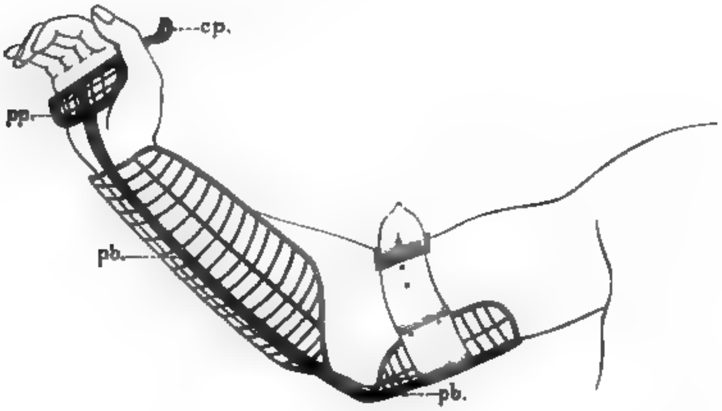
unciform, if sound. Otherwise, if difficulty be met with in shelling out this bone, the process may be cut through, the bone itself turned out, and the process subsequently taken away. The lower ends of the radius and ulna are now examined, each from the incision over them, and dealt with according to the amount of disease present. Thus in some cases erasion with a sharp spoon or gouge may be sufficient. In others the ends may be removed by M. Ollier's method of "modelling resection," a small saw being so used as to form a new articular end. The styloid processes should always be left, if possible; and even when all the articular cavity of the radius must go, some of the expanded end of the bone should be left so as to furnish a solid support for the hand. The periosteum all round each bone, and lateral ligaments, should be carefully retained when healthy. In young subjects the operator must be careful not to leave a caseating sequestrum in the epiphysial line above a section of bone which is apparently healthy. The same remarks apply to the treatment of the four inner metacarpals, which alone are usually diseased. The bases of any of these which require removal must be most carefully shelled out of their fibrous coverings, or the tendons and the deep palmar arch may be damaged. If more than gouging is required, the section is better made with a fine saw than with cutting-forceps.

Question of Preserving the Periosteum.—This step has been objected to on account of its increasing the risk of leaving tubercular mischief behind. M. Ollier strongly advocates the subperiosteal method. Though riddled with fistulæ and infiltrated with tubercular granulation tissue, the periosteum should be preserved, as much as is possible, after thorough curetting. This will aid in making the connection between the metacarpus and the forearm strong and not flail-like, while it will also help in the preservation of the carpal tendons. Prof. Ollier meets the above objection by a thorough use of the curette until only the actual fibrous tissue of the capsule, ligaments, and periosteum is left. If the consistency of this fibrous tissue is found to be altered in places, the actual cautery or the solid silver nitrate is trusted to.

The operation is a tedious and difficult one, requiring the minutest care throughout to avoid injury to important structures, and to get away all the diseased tissues.

Third Stage: Toilette, Cauterisation, and Drainage.—M. Ollier attaches great importance to these points. *Toilette.*—The tendons usually lie buried in tubercular granulation-tissue extending upwards and downwards to a varying degree. Every infected tendon-sheath must be slit up, and the tubercular material followed into every nook with scissors and curette. Each tendon must be individually drawn up with a blunt hook and inspected. To render the deeper ones accessible they should be pushed up from the palm, and, if it be needful to get directly at the flexor tendons, one or two incisions should be carefully made in the palmar surface. *Cauterisation.*—M. Ollier advises the use of the actual cautery to the most affected spots, with the view (1) of helping to eradicate the disease; (2) to prevent hæmorrhage; and (3) to obviate the risk of tubercular infection from the wound (M. Verneuil's "surgical auto-inoculation"). *Drainage.*—Drains of gauze should be freely employed between the different incisions, not only to prevent collections of fluid, but to keep the incisions open for future curetting. The dressings should be voluminous and firmly applied, so as to distribute the free oozing through a large amount of safe material. The Esmarch's bandage, which should have been put on high up in the forearm so as to admit of the application of the above-mentioned dressings, is then removed, and the limb put on the splint shown in Fig. 35. The first dressing should be left on, if possible, for eight or ten days. If needful the incisions must be kept open with drains for three or four weeks, that any suspicious granulation tissue may be repeatedly attacked with the sharp spoon, &c. Fifteen or twenty days after the operation the period of frequent dressings should begin for the purpose of repeated cauterisations. English surgeons will probably substitute for these the use of sharp spoons and free slitting up of any sinuses.[*]

FIG. 35.



Ollier's splint for cases of excision of the wrist (*Traité des Résections*, t. ii. p. 477).

pp, Support for the palm of the hand; this should reach below to the level of the lower transverse palmar crease. cp, A curved piece of flexible metal intended to separate the thumb from the fingers, or to support it in any desired position. pb, pb, Supports for arm and forearm, united to each other and to the palmar support by a stout wire, sufficiently supple, however, to admit of the curves being altered by means of the fingers only, so that painful pressure at any spot may at once be removed. When the wound is healed, and it is desired to alter the angle of the hand with the forearm, either antero-posteriorly or laterally, the palmar support may be attached to that for the forearm by a joint admitting of the double movement.

When the splint shown in Fig. 35 is left off, a support of plaster of Paris, or a leather splint made to lace up, should be employed as long as there is any tendency to displacement of the hand. Whatever support is employed, it should end below the metacarpo-phalangeal joints, so as not to interfere with the free flexion of all the joints of the fingers.

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[*] The above remarks refer only to cases of advanced tubercular disease. When excision is performed early before the stage of sinuses, &c., as should always be the case, it will often be possible to eradicate the tubercular disease at the time of the operation; the dressings will be few, and the after-use of the curette only occasionally needed.

After-Treatment.—This must be begun a day or two after the operation, and persevered with for six or nine months, the patient lending an untiring aid throughout the whole of this time. A day or two after the operation the finger-joints should be moved daily, care being taken not to disturb the wounds, and special care should be given to the metacarpo-phalangeal joints, which are liable to escape attention. Moreover, the thumb and index finger must be kept well apart. About eight or ten days after the operation, or as soon as the parts are sufficiently solid, careful movement of the wrist may be begun. Carrying dumb-bells of increasing weight, writing, piano-playing, and the like, are useful exercises. There is a persistent tendency for the tendons to remain adherent in their sheaths, only to be overcome by persevering, assiduous movements, and the use of nitrous oxide gas from time to time. Galvanism, faradism, friction, massage, are all of service when the wound is healed. If the surgeon wish for a good result in the case of hospital patients, he will not allow them to leave too early. As M. Ollier points out, and as his cases show, in addition to excellent movements of the fingers, extension and flexion, abduction and adduction of the hand on the carpus should be very largely recovered by long-continued perseverance. Extension of the fingers and wrist is more slowly regained than flexion, owing to atrophy of the dorsal muscles and matting of their tendons.* Even if the other fingers are stiff, mobility and power of approximation of the thumb and index will be much more useful than any artificial limb.

The following is the case of excision of the wrist by Ollier's method to which I referred at p. 49:

Mrs. D., æt. 37, was sent to me in January, 1896, by Dr. Wood, of Dover, with tubercular disease of the right wrist. There was the usual characteristic swelling on both aspects of the wrist, the fingers were stiff and extended, and the hand useless, but, as yet, there were no sinuses. The personal history of the patient, as well as her age and the local condition, was favourable. Excision was performed by an extension of M. Ollier's median dorsal incision. The pisiform and trapezium were left. Thin slices of the articular ends of the radius and ulna were removed with the saw, but it was only needful to treat the bases of the inner four metacarpals by vigorous curetting. Two lateral incisions were made for drainage. The parts healed quickly. As long as the patient could be kept in the hospital, M. Ollier's directions were assiduously attended to. She persisted, however, in going out in a month, and afterwards attended for a time only. and that erratically. I am indebted to Dr. Wood for the following notes of the case, made in November, 1898, nearly three years later:—"There is some undue prominence and mobility of end of ulna. Power of rotation, pronation and supination, perfect and painless. Hand can be flexed and extended on forearm to about half normal amount. Thumb. Movement of one phalanx on the other, also phalanx on metacarpal, perfect. The thumb can be flexed to touch palm of hand, and also any part of the flexor surface of any of the fingers. Fingers. Movement of terminal phalanges on middle phalanges, and of middle on proximal phalanges, perfect. Metacarpo-phalangeal joints: When the fingers are straight there is just a little flexion at this joint, and normal extension; but when phalanges are flexed on one another, then the metacarpo-phalangeal joints become quite rigid on attempting flexion.[*] She cannot make a complete fist. Generally, she has a thoroughly useful, though at present not a strong, hand. Asked whether she does her own washing, she replies, 'Yes, I do it, though I don't like it when the day comes round.' '

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* It has been suggested that some of the loss of power in the fingers and wrist depends on the tendons remaining too long after the removal of the diseased bones, and that shortening of the tendons should be practised. M. Ollier points out that the tendons, though too long at first, and weakened by interference with their grooves and the posterior annular ligament, tend to accommodate themselves to their altered surroundings, and that mobility of the fingers and strength in carrying articles depend much more on the amount of bone removed—and especially whether the ulna and radius were trenched upon,—on the old atrophy and degeneration of muscles, adhesions of tendons, stiffness of joints, and also on the patience and diligence with which the after-treatment is persevered with. Shortening of tendons is only recommended by him when the fingers tend to be obstinately flexed; he advises in this case shortening of the dorsal tendons by his method given at p. 46.

Question of Amputation in Tubercular Disease of the Carpus. As has been stated above, tubercular disease of the carpus more rarely occurs alone and isolated than any other tubercular joint affection. Thus the existence and degree of other tubercular lesions, the extent of the disease in the wrist, the age and vitality of the patient, the personal and family history, the presence of albuminuria and lardaceous disease, are some of the chief points which will help in deciding the above question. M. Ollier has recorded seven cases in which, owing to the existence of a cough, hæmoptysis, and suspected or actual disease of the apices, he advised amputation, but performed resection owing to his advice being rejected. The results are not encouraging. While excision of the wrist deserves a trial on a larger scale than it has hitherto received, it should only be attempted in patients whose vitality is sufficient, and who are not handicapped by serious disease elsewhere.

EXCISION OF THE WRIST FOR INJURY.—This will be still more rarely required. Mr. Pye (*Med. Times and Gaz.*, 1879, vol. ii. p. 582) published a case of compound dislocation in an adult.

Some bones were protruding through a transverse rent on the front of the wrist, the radial artery was uninjured, the ulnar could not be felt. The flexor carpi radialis and flexor longus pollicis were torn across. The ends of the radius and ulna were sawn off and the carpal bones removed, piecemeal, until only the trapezium and the distal part of the os magnum, which were apparently uninjured, were left. Strict antiseptic precautions were taken, and the wound healed rapidly. There was a steady regain in power in the wrist and hand, the patient being again able to carry his milk-pails.[†]

In the rare cases of dislocation of the wrist which are, otherwise, irreducible, in the commoner cases of injury to the lower epiphysis of the radius where reduction is impossible, in compound fractures of the lower end of the radius, partial resection would be indicated. In a later stage, where any of the above cases are not doing well, or have become infected, a complete excision would be best with rigorous antiseptic precautions.

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[*] This rigidity at the metacarpo-phalangeal joints was due, in part, to too much attention being given to the phalangeal joints, and to the patient being lost sight of too soon. It is rigidity at *the former* joints which prevents a good result being an excellent one, entailing, as it does, a certain degree of open claw, instead of a closed fist. Anyone reading through the after-histories frequently given by M. Ollier of his cases will be struck by the recurrence of the words, "Je ne puis pas faire du poing."

[†] Sir W. MacCormac (*Dub. Quar. Journ. Med. Sci.*, 1867, p. 281) publishes the case of a girl, aged 10, in whom he removed the whole of the left carpus and most of the metacarpus, for a machinery accident, the patient recovering with a useful limb.

Excision of Wrist for Gunshot Injury.—Dr. Otis (*Med. and Surg. Hist. of the War of the Rebellion*, part ii. p. 999 *et seq.*) states that ninety-six cases of excision of the wrist, varying much in extent, were returned.

Six of these were complete, and five recovered with the functions of the hand much impaired, but, all things taken into consideration, in a better condition than if they had been submitted to amputation. In the ninety partial excisions, ankylosis and extreme deformity appear to have been common. Generally the hand was strongly deflected to the radial side,* the fingers rigidly fixed, the skin over the projecting end of the ulna irritable and exposed to injury. "With our present experience of excisions of the wrist for injury, it seems probable that recovery unattended by ankylosis is seldom to be anticipated, yet that this result is not disastrous, provided the hand is in good position and the functions of the fingers are in some degree preserved." In a very few, loose, flail-like joints were observed, remediable by apparatus. Gurlt (quoted by M. Ollier), in examining into the results obtained by the German surgeons in the Franco-German war, only found one good result, eight moderately good, six bad, and one very bad.

The chief English authority of his day, Sir T. Longmore, wrote thus on this operation :†

"Gunshot wounds of the wrist are usually attended with so much injury to the tendons and other structures surrounding the joint that it is scarcely possible in such cases for the operation of resection to produce satisfactory results."

Possibly the advantages of antiseptic surgery and resort to tendon-suture will considerably modify the above opinion and results. The first step will be to render the wound aseptic if possible, to remove any shattered fragments, or to perform a partial excision (according to the amount of damage), and provide sufficient drainage. If the wound suppurate it should be irrigated; and, as soon as possible, the wrist excised. M. Ollier (*Traité des Résections*, t. ii. p. 494) gives an instructive case of primary partial excision (first row of carpal bones and the ends of the radius‡ and ulna) for a gunshot injury in a lad, æt. 13. The shot had "balled." and the extensor tendons were severely damaged. The case was kept under observation for seven years, and the last report ends: "As far as the daily use of my hand goes, I might say that I have never had a wound."

Causes of Failure after Excision of the Wrist.—These are, mainly:

1. Persistent sinuses and discharge set up by remaining caries or necrosis. Sir W. Fergusson (*Path. Soc. Trans.*, vol. viii. p. 391) showed a specimen in which all the bones were supposed to have been removed by a single incision on the ulnar side. The pisiform, trapezium, and part of the unciform had been left. The movement of the fingers was good, but sinuses remained on both sides communicating

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* As this appears to be irremediable by any apparatus, Dr. Otis suggests that it should be met by always removing the carpal end of the ulna at the same level with the section of the radius, whenever it is necessary to remove the lower end of the latter.

† *Syst. of Surg.*, vol. i. p. 552.

‡ It is particularly mentioned that, in sawing the bone, no attempt was made to get above the fissures which ran up into the diaphysis.

with a bare piece of radius. Death took place from phthisis. Mr. J. Hutchinson (*ibid.*, vol. xvii. p. 239) showed a specimen of wrist-joint after partial resection by Mr. Stanley. Though no active caries was present, discharge was kept up by a necrosed bit of bone in a cavity at the back of the carpus. Death here also took place from chronic phthisis. This specimen is figured and briefly described, *Brit. Med. Journ.*, 1874, vol. i. p. 11. 2. Matting and sloughing of tendons, and consequent stiffness of fingers. 3. Phthisis.

AMPUTATION THROUGH THE WRIST-JOINT

(Figs. 11, 36 and 37).

The value of this operation has been a good deal disputed. It has been thought by some* "that it possesses no particular advantage; the length of the stump is of no great consequence; the flaps, with the numerous tendons in them, may not heal readily." Others† have gone further, and said that the long stump is found by instrument-makers difficult to fit with an artificial hand. That this is certainly not always the case is shown by Mr. H. Bigg‡ from two cases, one a Commander R.N., the other an artisan in the Woolwich Arsenal, both of whom, after being fitted with artificial hands, were able to engage actively in their respective employments.

As the above objections are scarcely sufficient, and as this amputation preserves, if the parts heal quickly, good pronation and supination, it should be practised whenever opportunities arise. These, however, as is shown below, will not be numerous.

Indications.

1. Extensive injuries (gunshot and otherwise) of a hand not admitting of the preservation of any fingers, and in which the damage of soft parts does not necessitate amputating through the forearm. On this subject I would refer my readers to the section on "Conservative Surgery of the Hand," p. 14. 2. Disease of carpus locally too far advanced for excision, or rendered by age, condition of health, &c., inappropriate for excision (p. 58). 3. Cases of failed excision. But in carpal disease the soft parts are often so much damaged by sinuses and other results of the disease that the surgeon is driven to amputate higher up; and where this may not be the case, the articular surfaces of the radius and ulna, owing to disease, have to be removed, the operation thus ceasing to be correctly amputation through the wrist-joint.§ 4, 5 and 6. More rarely still, for the results of palmar suppuration, gangrene, or burns.

Operations.—As in other amputations where the amount of skin available varies considerably, several methods will be given. The first of these is the best.

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* Sir W. Fergusson, *Pract. Surgery*, p. 325.

† John Bell, *Manual of Surgical Operations*, p. 53.

‡ *Artificial Limbs and Amputations*, p. 83.

§ Disarticulation has these advantages over entire removal of the styloid processes (*vide infra*): (1) There is no risk of necrosis. (2) Rotation of the forearm is not interfered with. (3) The supinator longus is left to powerfully flex the forearm. (4) The stump is longer and more useful.

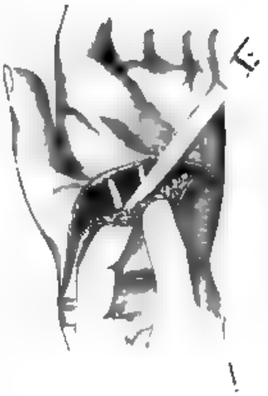
Different Methods.

1. Long palmar flap (Figs. 36, 37).
2. Equal antero-posterior flaps (Fig. 11).
3. Method of Dubreuil (Fig. 37).
4. Circular amputation.
5. Long dorsal flap, by Teale's method.

1. **Amputation by a Long Palmar Flap** (Figs. 36 and 37).—This has the advantage of preserving skin thick, well used to pressure, and abundantly supplied with blood; the nerves are also cut square, and disarticulation is easy.

The brachial artery being secured, the limb is brought to a right angle to the patient's side, and the hand, supinated,[*] is supported by an assistant, or rests on a sterilised towel on a small table. The wrist is now extended, the styloid processes defined, and the thumb abducted so as to make the palmar tissues tense. An incision is next made (on the left side) from the tip of the styloid process of the radius[†] straight down well on to the thenar eminence, and then curving across (about on a line with the level of the superficial palmar arch[‡]), and marking out a well-rounded flap by passing over the hypothenar eminence to the tip of the styloid process of the ulna. This flap is next dissected up, without scoring, cleanly off the flexor tendon, as far as the level of the wrist-joint; it should contain on its under surface some of the fibres of the thenar and hypothenar muscles. If this precaution be taken, the flap will contain the superficialis volæ and ulnar arteries, and thus run no risk of sloughing.

FIG. 36.



The hand being now pronated and flexed at the wrist-joint, an incision, slightly convex, is made across the wrist from one styloid process to the other. The palmar flap being now retracted, the hand is strongly flexed and the joint opened on the outer side first; the soft parts in front and behind are now severed with a circular sweep (the assistant pulling slightly on the hand), the remaining ligaments divided, and the hand removed. At this stage the extensor tendons must be cut boldly and cleanly, otherwise they will be ragged. If the articular cartilages of the radius are diseased, they must be dealt with either by gouging or, if necessary, by a clean section above the articular cartilage, a step which will interfere with free pronation and supination later on.

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[*] If the operation is, thus, commenced from the front, the hand need only be turned over once. If the dorsum is attacked first, the hand must be turned twice, first to make the palmar flap, and secondly to disarticulate. (Farabeuf.)

[†] The tip of this is nearly on a level with the intercarpal joint, being ½ inch below and somewhat in front of the styloid process of the ulna. On a level with the latter will be found the line of the wrist-joint. The two furrows in front of the wrist are both below the level of this joint. The lower one corresponds to the upper edge of the anterior annular ligament and the intercarpal joint. If the soft parts are much swollen, comparison with, and measurements taken from, the opposite wrist will be helpful.

[‡] This level is usually low enough. If the parts on the dorsum are damaged, the palmar incision may be made longer.

The apices of the styloid processes should in any case be removed, but the base of that of the radius should always be left if possible, to secure the action of the supinator longus. In amputating at the wrist-joint care should be taken, by keeping the point of the knife towards the carpus, not to open the radio-ulnar joint, so that there be no interference with pronation and supination.

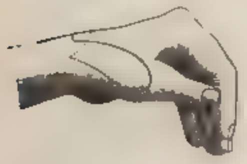
The radial, ulnar, the two interosseous, and the superficialis volæ arteries will probably need securing. Any sinuses present are now scraped out with sharp spoons, and the tendons trimmed. From the facility with which these last slip up into their sheaths, antiseptic precautions should be carefully taken.

Another Method. This consists in marking out the palmar flap (but not dissecting it up), opening the joint by a dorsal incision as above given, and then cutting the palmar flap by transfixion, the knife being passed behind the bones. As in this method it is difficult to avoid hitching the knife on the pisiform and unciform bones, and to obviate a jagged edge to the palmar flap, and as the flexor tendons, being relaxed, are pulled out by the knife instead of being cut cleanly, I do not recommend it.

2. **Amputation by Equal Antero-posterior Flaps** (Fig. 11).—The surgeon may be obliged, where the soft parts are scanty, to make use of this method. The objections to it are that if the tissues are thin there is some risk that the cicatrix may be adherent to the bones, and that these will be but poorly covered. During healing the draining is less satisfactory.

3. **Amputation at the Wrist by the Method of Dubreuil*** (Fig. 37).—In a very few rare cases, *e.g.*, where the soft parts on the back and front of the wrist are much damaged, perforated by sinuses, &c., this ingenious method may be made use of. But the objection to it is obvious. Where the thumb is sufficiently healthy to afford soft parts for a flap, it should be saved.

Fig. 37



The hand being pronated, the surgeon commences, at a point at the junction of the outer with the middle third of the back of the forearm, a little below the level of the wrist-joint, a convex incision, which reaches at its summit the middle of the dorsal surface of the thumb, and terminates in front, just below the palmar aspect of the wrist, at the junction of the outer with the middle thirds of the forearm. The flap, consisting of skin and fasciæ, having been raised, the two ends of its base are joined by an incision at a right angle to the long axis of the forearm. Finally, disarticulation is performed, beginning at the radial side. If needful, the flap may be taken from the hypothenar eminence, by reversing the incisions.

4. **Circular Amputation at the Wrist.**—This method is only suited to patients with thin, lax skin, and even in them it is often difficult to raise the skin quickly and neatly, for it is here adherent to some of the adjacent parts, as at the base of the hypothenar eminence. Moreover, cutting through such a thin, lax skin may be followed by sloughing, especially if its vitality is impaired by sinuses, &c.

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* *Précis d'Opérations de Chirurgie*, par le Dr. J. Chauvel, p. 171.

The hand being supported by an assistant, the surgeon draws up the skin of the forearm, and makes his first circular incision through the skin on a level with the carpo-metacarpal joints of the little finger and thumb, encroaching thus upon the thenar and hypothenar eminences, two inches below the styloid processes. The skin being retracted by freeing the soft parts with light touches of the knife, another circular sweep is made just above the level of the pisiform bone, so as to sever cleanly the numerous tendons, together with the vessels and nerves. The joint is then opened, and the styloid processes removed.

5. **Amputation at the Wrist by a Long Dorsal Flap.**—This method on Mr. Teale's principle is not to be recommended. If a skin-flap alone be taken, its poor vitality will probably end in sloughing; if the tendons be taken up as well, but little additional vascularity is gained, while the flap is inevitably somewhat ragged. If this method has to be employed, the convexity of the flap should lie over the centre of the metacarpals.

LIGATURE OF THE RADIAL ARTERY ON THE BACK OF THE WRIST* (Figs. 7 and 38).

GUIDE.—A line drawn from a point just internal to the apex of the styloid process to the back of the first interosseous space.

RELATIONS:—

IN FRONT.

Skin, fasciæ; branches of superficial radial vein, and of radial and musculo-cutaneous nerves; fibro-fatty tissue beneath deep fascia.

Three extensor tendons of thumb.

Radial artery
on back of wrist.

OUTSIDE.	BEHIND.	INSIDE.
V. comes.	Styloid process; external lateral ligament; trapezium; carpal ligaments.	V. comes.

Indications.—Few; usually wounds, *e.g.*, by the slipping of a chisel, by breaking crockery, &c. In such cases both ends† would, of course, be secured, and the surgeon would examine as to injury to any of the extensor tendons (p. 33).

Operation.—The limb should rest upon its ulnar margin, steadied by an assistant, who with one hand holds the fingers, and with the other so moves the thumb as to make the tendons project. In the living subject these should be thrown into action, and their position and that of the radial vein defined before the operation. The incision, 1½–2 inches long, may be in the above line or parallel with the tendons. In either case it should be over the lower part of the vessel, just before it dips between the heads of the first dorsal interosseous into the palm. It should be made lightly, so as not to damage the radial vein or, deeper down, the tendons. The radial vein having been drawn aside with a blunt hook, and the deep fascia carefully opened, the tendons are pulled out of the way and the artery separated from its veins. The ligature may be passed from either side. The artery lies deeper than would be expected, usually covered by fatty tissue. If the parts need relaxing, the hand should be hyper-extended. All injury to the closely contiguous tendon-sheaths or joints must be avoided; and, for the same reason, union of the wound without suppuration is particularly indicated here.

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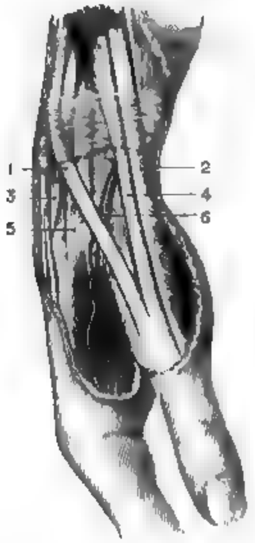
* The so-called "tabatière anatomique," a triangular space bounded externally by the extensor ossis metacarpi and extensor primi internodii, internally by the extensor secundi internodii; its apex is formed by the meeting of these tendons, and its base by the lower edge of the posterior annular ligament or base of the radius.

† It may be difficult to find the distal end of the artery, owing to its tendency to retract (Butcher, *Operative Surgery*, p. 407).

FIG 38.



Anatomy of radial artery on the back of the wrist. (Heath.) 1, Extensor secundi internodii. 2, Extensor ossis metacarpi. 3, Extensor carpi radialis brevior. 4, Extensor primi internodii. 5, Extensor carpi radialis longior. 6, Radial vessels.

In the following case aseptic surgery and the tying of diseased arteries with sterilised silk, and not too tightly, answered well:—

M. A. S., æt. 60, was sent to me, November, 1899, by Dr. Verrall, of the Old Kent Road, with an aneurysm of the right radial artery. Patient, old for her years, was operated on for cataract at 46. Superficial arteries tortuous and hard. No evidence of heart disease. An aneurysm the size of a large walnut on the outer and dorsal aspect of the right radius, just where shaft and styloid process join, and extending into the "tabatière anatomique," had begun four years before. At first of the size of a nut, it had gradually increased till a month ago, when it became rapidly larger. November 17: The radial was tied just above the swelling, and again where the artery dips between the heads of the abductor indicis. Sterilised silk was used, and the veins were included in the first ligature. Specks of atheroma were seen in the radial artery when exposed in the palm. The aneurysm was then incised and a good deal of pink laminated clot turned out. The wound ran an aseptic course; the aneurysm shrank and disappeared; the only trouble being some dermatitis caused by the iodoform gauze on a very aged skin.

CHAPTER III.

OPERATIONS ON THE FOREARM.

LIGATURE OF RADIAL IN THE FOREARM (Figs. 39, 40).

In the upper two-thirds the artery is submuscular; in the lower third it is subfascial.

Line.—From the centre of the bend of the elbow (where the artery is given off opposite to the neck of the radius) to a point just internal to the styloid process of the radius.

Guide.—The above line, and the inner aspect of the supinator longus.

Relations:—

In Front.

Skin, fasciæ, viz., superficial, deep, and another layer, varying in distinctness, which ties the radial to the supinator longus and pronator radii teres.
Branches of the musculo-cutaneous nerve, especially below.
Superficialis volæ below.
Transverse branches of venæ comites.
Supinator longus overlapping.

Outside.	Inside.
Supinator longus.	Pronator radii teres.
Radial nerve (middle third).	Flexor carpi radialis.
Vein.	Vein.

Radial artery in forearm.

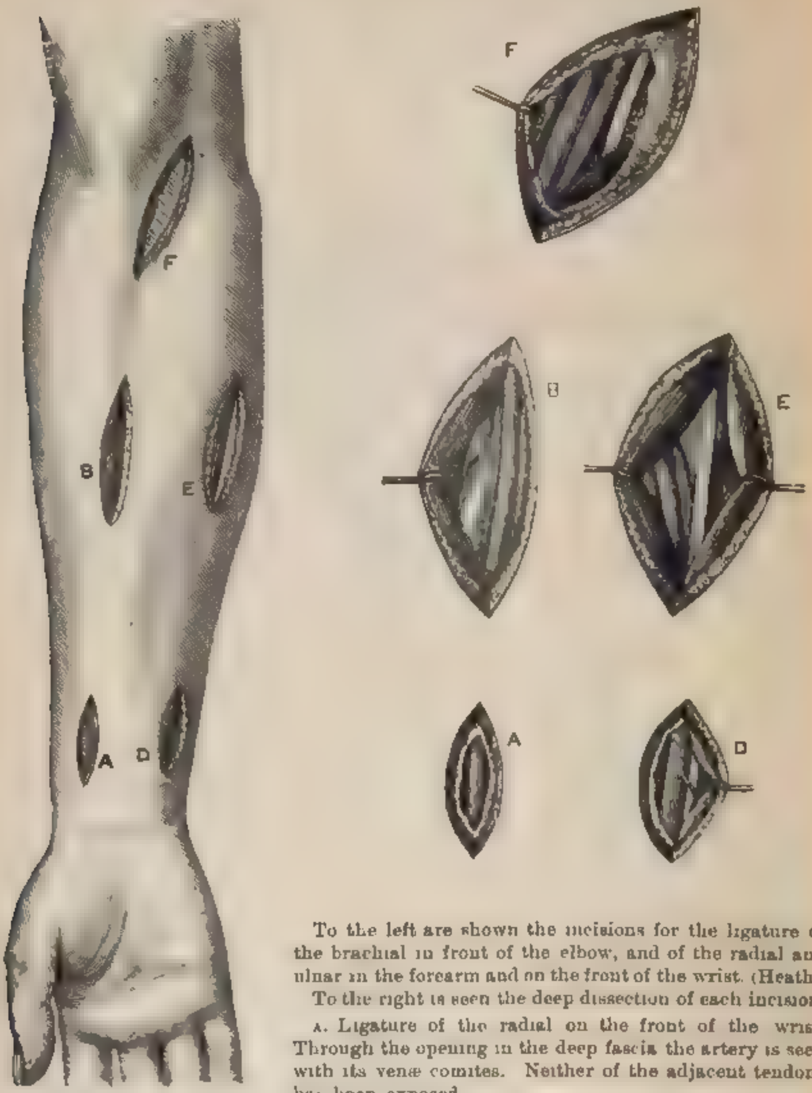
Behind.

Biceps.
Supinator brevis.
Pronator radii teres.
Flexor sublimis digitorum.
Flexor longus pollicis.
Pronator quadratus.
Radius.

Indications.

(1) Wounds; stabs; cuts with glass, &c. (2) Traumatic aneurysm. In these cases, the limb having been rendered evascular by Esmarch's bandages, the surgeon opens the swelling, turns out the clot,

FIG. 39



To the left are shown the incisions for the ligature of the brachial in front of the elbow, and of the radial and ulnar in the forearm and on the front of the wrist. (Heath.)

To the right is seen the deep dissection of each incision.

A. Ligature of the radial on the front of the wrist. Through the opening in the deep fascia the artery is seen with its venæ comites. Neither of the adjacent tendons has been exposed

B Ligature of the radial in the forearm. The supinator longus has been drawn aside. The radial vessels are lying here on the insertion of the pronator radii teres. The radial nerve is indicated in shadow, lying external to the vessels and on rather a deeper plane

D Ligature of the ulnar on the front of the wrist. The process of deep fascia given off from the extensor carpi ulnaris (p. 69) has been opened and drawn aside, exposing the ulnar vessels, with the nerve lying internal to them.

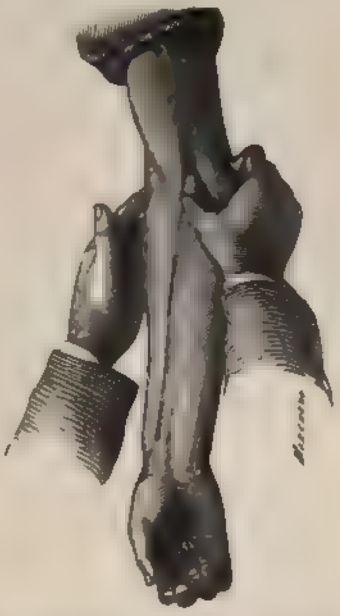
E Ligature of the ulnar in the forearm. The flexor carpi ulnaris internally, and the flexor sublimis or palmaris longus externally, have been drawn aside. The ulnar vessels, nerve, and part of the flexor profundus are seen at the bottom of the wound

F. The brachial artery, with its venæ comites, is seen to the left, the median nerve to the right. All these are represented as somewhat too large Some fibres of the pronator radii teres are shown in the lower angle of the wound, a few of the brachialis anticus are seen more deeply.

ligatures the artery above and below. If he prefers it, he may snip out the swelling and twist both ends of the artery. The first method is, on the whole, the most generally applicable. (3) Punctured wounds of palmar arch Ligature of the radial and ulnar is preferred by some, but I would refer my readers to the remarks at p. 27.

A **Ligature in the Lower Third of the Forearm** (Figs. 39, 40).—The forearm having been completely supinated and the wrist extended at first, the surgeon, seated comfortably, makes an incision, 2 inches long, midway between the tendons of the supinator longus and flexor carpi radialis, or (if there be much swelling) exactly in the line of the artery, going lightly* through the skin and subcutaneous tissue. A large branch of the radial vein, which is usually met with subcutaneous and just under the incision, is now drawn aside or divided between two ligatures. The deep fascia, here very thin, is slit up on a director, and the wrist now flexed to relax the parts. The artery being separated from the venæ comites,† the needle may be passed in either direction. Damage to any of the tendon-sheaths should be most carefully avoided

FIG 40



Determination of the centre of the bend of the elbow The left index is placed upon the epicondyle, the right upon the epitrochlea, while the right thumb occupies the centre of the fold of the elbow, to the inner side of the biceps tendon which projects beneath the soft parts The line of the radial artery has been traced in its intermuscular furrow (Farabeuf.)

B **Ligature in the Middle Third of the Forearm.**

GUIDE.—Line of artery p. 65).

RELATIONS (p. 65).—The nerve is now on the outer side of the artery, but not very close to it.

The steps are very much as above, but the artery is lying deeper. The radial vein, if present, must again be avoided. The incision over the middle third of the artery should be 2½ inches long, and the parts well relaxed when the deep fascia is opened; the inner aspect of the supinator longus is next defined, and this muscle drawn well outwards. The layer of fascia which unites the artery to the supinator and pronator must now be opened. The needle should be passed from without inwards

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* So as to avoid the radial vein, which always, and the superficialis volæ, which sometimes, lie superficial here, just under the deep fascia, which is very thin. On the dead subject, especially, it is easy for the student to get down to or below the artery with his first incision.

† These, owing to the free collateral venous currents, may be tied in if it is found very difficult to separate them from the artery.

C. Ligature in the Upper Third of the Forearm (Figs. 39, 40).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS (p. 65).—The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least 2½ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 39, B), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles having been relaxed by bending the elbow and wrist joints, and the cellular interval between them opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM
(Figs. 39, 40).

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two-thirds of the vessel will be a line drawn from the tip of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM:—

IN FRONT.

Skin; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.	INSIDE.
Flexor digitorum sublimis.	Flexor carpi ulnaris.
Vein.	Ulnar nerve.
	Vein.

Ulnar artery in forearm.

BEHIND.

Brachialis anticus.
Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 65.

Ligature in the Lower Third of the Forearm (Fig. 39).—Position of hand supinated, to begin with. An incision, commencing just above the pisiform bone, and 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. This varies: sometimes it is extremely thin; at others a second process is present, given off from the flexor carpi ulnaris, and tying the ulnar vessels and nerve to the flexors of the fingers. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third* of the Forearm (Fig. 39).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins having been drawn aside or secured with double ligatures, and the wound sponged dry, a white line,† which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here having been carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve, which lies to the inner side, and joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it if possible (footnote, p. 67), the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject, owing to the depth of the vessel, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination-test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb. 2. Making the incision too short, or too much to the inner or the outer side, and thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor profundus, or that between the flexor sublimis and the palmaris longus.

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* The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

† This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

C. Ligature in the Upper Third of the Forearm (Figs. 39, 40).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS (p. 65).—The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least 2½ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 39, B), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles having been relaxed by bending the elbow and wrist joints, and the cellular interval between them opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM (Figs. 39, 40).

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GUIDE.—The above line and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM :—

IN FRONT.

Skin ; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.		INSIDE.
Flexor digitorum sublimis.		Flexor carpi ulnaris.
Vein.		Ulnar nerve.
		Vein.
	Ulnar artery in forearm.	

BEHIND.

Brachialis anticus.
Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 65.

Ligature in the Lower Third of the Forearm (Fig. 39).—Position of hand supinated, to begin with. An incision, commencing just above the pisiform bone, and 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. This varies: sometimes it is extremely thin; at others a second process is present, given off from the flexor carpi ulnaris, and tying the ulnar vessels and nerve to the flexors of the fingers. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third* of the Forearm (Fig. 39).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins having been drawn aside or secured with double ligatures, and the wound sponged dry, a white line,† which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here having been carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve, which lies to the inner side, and joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it if possible (footnote, p. 67), the ligature is passed from within outwards.

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* The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

† This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

C. Ligature in the Upper Third of the Forearm (Figs. 39, 40).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS (p. 65).—The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least 2½ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 39, B), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles having been relaxed by bending the elbow and wrist joints, and the cellular interval between them opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM
(Figs. 39, 40).

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two-thirds of the vessel will be a line drawn from the tip of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM:—

IN FRONT.

Skin; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.	INSIDE.
Flexor digitorum sublimis.	Flexor carpi ulnaris.
Vein.	Ulnar nerve.
	Vein.

Ulnar artery in forearm.

BEHIND.

Brachialis anticus.
Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 65.

Ligature in the Lower Third of the Forearm (Fig. 39).—Position of hand supinated, to begin with. An incision, commencing just above the pisiform bone, and 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. This varies: sometimes it is extremely thin; at others a second process is present, given off from the flexor carpi ulnaris, and tying the ulnar vessels and nerve to the flexors of the fingers. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third* of the Forearm (Fig. 39).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins having been drawn aside or secured with double ligatures, and the wound sponged dry, a white line,† which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here having been carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve, which lies to the inner side, and joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it if possible (footnote, p. 67), the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject, owing to the depth of the vessel, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination-test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb. 2. Making the incision too short, or too much to the inner or the outer side, and thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor profundus, or that between the flexor sublimis and the palmaris longus.

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* The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

† This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

C. **Ligature in the Upper Third of the Forearm** (Figs. 39, 40).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS (p. 65).—The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least 2½ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, or secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 39, B), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles having been relaxed by bending the elbow and wrist joints, and the cellular interval between them opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

LIGATURE OF ULNAR ARTERY IN THE FOREARM

(Figs. 39, 40).

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two-thirds of the vessel will be a line drawn from the tip of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM :—

IN FRONT.

Skin ; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous
nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.	INSIDE.
Flexor digitorum sublimis.	Flexor carpi ulnaris.
Vein.	Ulnar nerve.
	Vein.

Ulnar artery
in forearm.

BEHIND.

Brachialis anticus.
Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 65.

Ligature in the Lower Third of the Forearm (Fig. 39).—Position of hand supinated, to begin with. An incision, commencing just above the pisiform bone, and 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. This varies: sometimes it is extremely thin; at others a second process is present, given off from the flexor carpi ulnaris, and tying the ulnar vessels and nerve to the flexors of the fingers. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third[*] of the Forearm (Fig. 39).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins having been drawn aside or secured with double ligatures, and the wound sponged dry, a white line,[†] which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here having been carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve, which lies to the inner side, and joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it if possible (footnote, p. 67), the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject, owing to the depth of the vessel, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination-test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb. 2. Making the incision too short, or too much to the inner or the outer side, and thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor profundus, or that between the flexor sublimis and the palmaris longus.

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[*] The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

[†] This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

Aids.

1. Keeping carefully to the above-given line. 2. Hitting off the right intermuscular septum and corresponding sulcus. 3. Finding a muscular branch, and using it as a guide to the artery.

If a wrong space is much opened up in the living subject, the contiguous muscles should be brought together with sterilised chromic catgut sutures cut short, due drainage being provided, if needful.

EXCISION OF THE RADIUS OR ULNA.

Indications.—(1) New growths, especially myeloid; (2) Tubercular osteitis, *e.g.*, of the lower end of the radius, caseating, and resisting erasion. It is only in the last class of cases that any special difficulty will occur, and it is to these, accordingly, that the following account applies.

Operation for Removal of the Radius.—This is the bone of the forearm in which myeloid sarcomata usually originate. The following is taken from a most successful case by Mr. H. Morris (*Clin. Soc. Trans.*, vol. x. p. 138), in which he removed the radius and ulna extensively, for a myeloid growth originating in the former, and firmly attaching the ulna to it.

Esmarch's bandage having been applied, a long incision was made over the outer side of the radius, from the styloid process to the upper third. The radial nerve was used as a guide to the interval between the supinator longus and extensor carpi radialis longior, Mr. Morris having found on the dead subject that he could most readily separate the soft structures from the front and back of the radius by going between those muscles, and keeping the supinator to the fore part of the incision. The supinator longus and pronator teres at their insertions having been detached from the radius, the bone, when freed of its muscles in front and behind, was sawn through at the lower edge of the supinator brevis. A second longitudinal incision of less extent than the first was made along the inner side of the ulna from the wrist-joint upwards, and through it the rest of the soft parts separated from the tumour and ulna. This bone was sawn between 3 and 4 inches above the wrist, and the lower ends of both bones disarticulated by opening the wrist-joint on the inner side. The entire tumour, with the ulna and pronator quadratus, was then removed *en masse*. The anterior interosseous artery was divided just above the pronator quadratus, but no other large branches were injured. The wounds healed in about seven weeks. As soon as a light leather splint was moulded on to the forearm and wrist the usefulness of the hand steadily increased. Four years later Mr. Morris brought the patient before the Clinical Society (*Trans.*, vol. xiii. p. 155, pl. vi.). There was no recurrence. By the aid of a leather splint the patient was able to nurse, dress, carry, and wash and care for her children, do her household work, and wash the house-linen. She could also stitch and darn, and pick up a pin. Latterly, since contraction had taken place, she could hold her hand out straight without any support.*

In 1896 a girl of 13 came under my care with tubercular osteitis of the lower end of the right radius, with two sinuses on the outer and dorsal aspect of the bone, the result of previous operations. Amputation of the forearm had been advised at a provincial hospital. The extensor communis was the seat of a ganglion, which on removal proved to be also tubercular. The epitrochlear gland was also involved. As repeated erasion failed to bring about a cure, I removed the lower end of the radius. When the patient was seen, in March 1899, the hand was displaced outwards and weaker than its fellow, but otherwise as useful. Healing was everywhere sound. The movements of the fingers were excellent. No apparatus was required.

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* After these operations, as in any in which the flexors and extensors of the fingers must, of necessity, be meddled with, passive movement of the fingers should be commenced very early and energetically persevered with.

Operation for Removal of the Ulna.—In the very much rarer cases of myeloid tumours springing from the ulna, the following may be the course adopted. The account is taken from a paper by Mr. Lucas (*Clin. Soc. Trans.*, vol. x. p. 135).

A longitudinal incision, about 4 inches long, exposed the tumour between the flexor and extensor carpi ulnaris. In making this the dorsal branch of the ulnar nerve was divided. The soft parts having been next retracted, the bone was exposed above the level of the tumour, and sawn through. The piece connected with the tumour was next drawn out of the wound, while the interosseous membrane was divided, and the extensor indicis on the posterior, and the pronator quadratus on the anterior, separated from the tumour. The removal was completed by dividing the ligaments of the lower radio-ulnar joint, the attachment of the triangular fibro-cartilage to the ulna, and the internal lateral ligament. The patient left the hospital in five weeks, the resulting usefulness being excellent.

Mr. Clutton has reported three instructive cases of endosteal sarcoma of the radius (*Clin. Soc. Trans.*, vol. xxvii. p. 86 *). Two of the cases affected the lower end of the bone. In one not only the lower end of the radius (the diseased bone), but that of the ulna also was removed,† "so that the hand might be left in a straight line with the forearm." The result of this step was that, while the limb was useful in the patient's occupation—that of a painter—as long as he wore a leather gauntlet, without this aid he could do nothing.‡ Examination of the specimen showed that the ulna was quite free. A point of especial interest in this case is the fact that on examination of the same section of the radius a small nodule of growth was seen still left in the medullary canal. This was scraped and gouged away. In the second case, also of the lower end of the radius, amputation was performed, as the growth was thought to be parosteal or periosteal. Examination of the specimen showed that it was endosteal, and Mr. Clutton allowed that a free incision might have shown that resection and saving the hand were possible. The third was a myeloid growth of the upper end, head and neck, of the radius. This was successfully removed by an incision on the outer side over the most prominent part of the tumour, "the radius being divided an inch below the growth." This patient died, eighteen months later, of renal disease present before the operation. No recurrence took place in any of the three cases. Slowness of growth and regularity of expansion of the bone seem to be the most important guides in the diagnosis of endosteal from periosteal sarcomata, and in the choice between such steps as resection or erasion and amputation. Crackling and pulsation are also very valuable, if present. They were absent in all three of Mr. Clutton's cases, and it is noteworthy that, while the growth which involved the upper end of the radius appeared to be exceedingly hard and resistent, as if entirely bony, it turned out to be soft, almost diffluent. A free exploratory incision is the only reliable guide, as it is certain that the malignancy of endosteal sarcomata varies within wide limits, some growing slowly and evenly inside the bone, others perforating it in one or more places. In such cases, after resection, the patient should be watched carefully and for several years.

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* An abstract will be found in the *Lancet*, Feb. 3, 1894, p. 270.

† I would most strongly dissuade my readers from taking this step. Only the bone affected should be removed. Lateral displacement of the hand will follow, but it will not be a flail, and, as contraction takes place, the hand will rapidly gain strength, and no apparatus, requiring frequent renewal, will be needed.

‡ Two years after the operation "the strength of the hand was steadily increasing," but nothing is said of the amount of support required.

Excision of the Radius and Ulna in Military Surgery. —By this is meant deliberate removal of portions of these bones damaged by gunshot or other injuries, not the mere picking away of spicules and fragments.

Dr. Otis* divides the cases into the three groups of primary, intermediary (before the thirtieth day), and secondary (after the thirtieth day). Though caries and attempt at repair were met with in these latter cases, there was no time for invagination of sequestra. Thus they were very different from necrosis operations, and hence, in great measure, the high mortality. Of the primary 10 per cent., and of the intermediary 19 per cent., ended fatally; the mortality of the secondary was nearly as high as that of the primary excisions.

The concluding observations of Dr. Otis are worthy of the most careful attention of military and naval surgeons:

> "Of this large number of excisions in the continuity of the forearm there is little to remark save that, in the aggregate, the mortality of shot-fractures of the bones of the forearm appears to have been sensibly augmented by operative interference, and that I have sought in vain for a single instance in which a formal excision of a portion of the shaft of either radius or ulna had a really satisfactory result as regards the functional utility of the limb. The representations of Baudens of his Algerian experience led the German surgeons to practise these excisions in the shafts of long bones to some extent in the Danish and Austrian campaigns, with very unsatisfactory results. Similar operations were resorted to with comparative frequency during the American war, and the results plainly indicate, I think, that formal primary operations of this nature should be banished from the practice of military surgery. It is bad enough to remove adherent primary sequestra, for our museum abounds in examples where such fragments have retained their vitality and maintained the continuity of long bones; it is worse to deliberately remove unoffending healthy portions of the bone. The mortality, greatly exceeding that of the expectant conservative treatment, the numerous consecutive amputations, and the large proportion of hopelessly deformed limbs sufficiently condemn such operations. I have found nothing in the reports of the surgery of the late Franco-German war that was not conformable to these conclusions."

Sir T. Longmore (*System of Surgery*, vol. i. p. 544) brings the following striking experience to bear on these cases:

> "I have seen many of these fractures in which primary resection of a portion of the entire shaft by a shot has occurred, and have not met with bony union in any case where the gap was a full inch in amount."

Causes of these Resections doing Ill or Failing.

1. Osteo-myelitis.
2. Pyæmia.
3. Hectic.
4. Hæmorrhage.
5. Painful irritable cicatrices.
6. Non-union. False joint. Flail-like limb.
7. Displacement of the hand at the wrist.
8. Permanent contraction of flexor or extensor tendons.

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* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 935 *et seq.*

AMPUTATION OF THE FOREARM (Figs. 41 to 44).

Practical Anatomical Points.—In this frequently-performed operation the following should be kept in view:

(*a*) The two bones are not fixed, like those in the leg, but movable. This mobility may prevent their being parallel when the knife is sent across in transfixion, and thus lead to penetration of the interosseous membrane: it must also be remembered in sawing the bones. Lastly, on this mobility in pronation and supination depends the usefulness of the stump, which must therefore be left as long as possible, the bones being always, when practicable, sawn well below the insertion of the pronator radii teres into the middle of the outer surface of the radius. If the bones be divided above the insertion of the pronator teres, the radius will become supinated and further rotation movements will be lost.

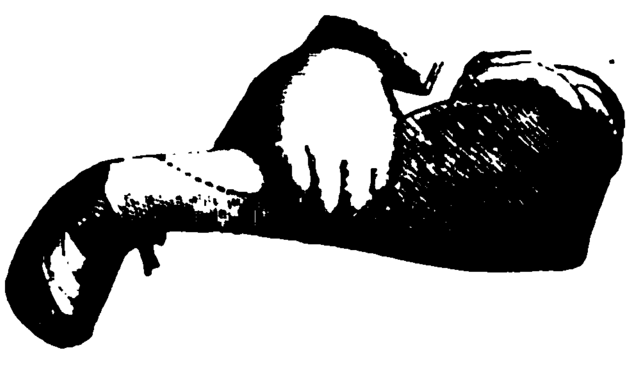
(*β*) In the upper part of the forearm, both in front and behind, are fleshy bellies; below, the soft parts are increasingly tendinous. Furthermore, the anterior border of the radius and the posterior of the ulna, especially the latter, are largely subcutaneous.

Different Methods.

1. Skin flaps, antero-posterior or lateral, with circular division of muscles, &c.
2. Transfixion flaps.
3. Circular.
4. Teale's.

1. **Amputation of the Forearm by Skin Flaps, with Circular Division of Muscles, &c.** (Figs. 41, 42, 43).—While, in an amputation so often called for, it is well to practise several methods, none, on the whole, answers so well as this, for the following reasons: (*a*) By cutting one flap a little longer than the other, sufficient skin can always be obtained to give a good stump. (*β*) Transfixion, while quite unsuited to the lower third, owing to the numerous tendons, can only be performed in the upper third in moderately muscular forearms with ultimate satisfaction. For in a bulky, fleshy limb (as in a case of accident in a male adult) it is not easy always to cut the skin longer than the muscles in bringing out the knife, and so to prevent the tendency of the fleshy bellies to protrude while the flaps are being united; and a little later, these muscles, with large surfaces cut obliquely, give rise to a good deal of blood-stained oozing, which is very likely to cause tension, suppuration, and delay in healing.

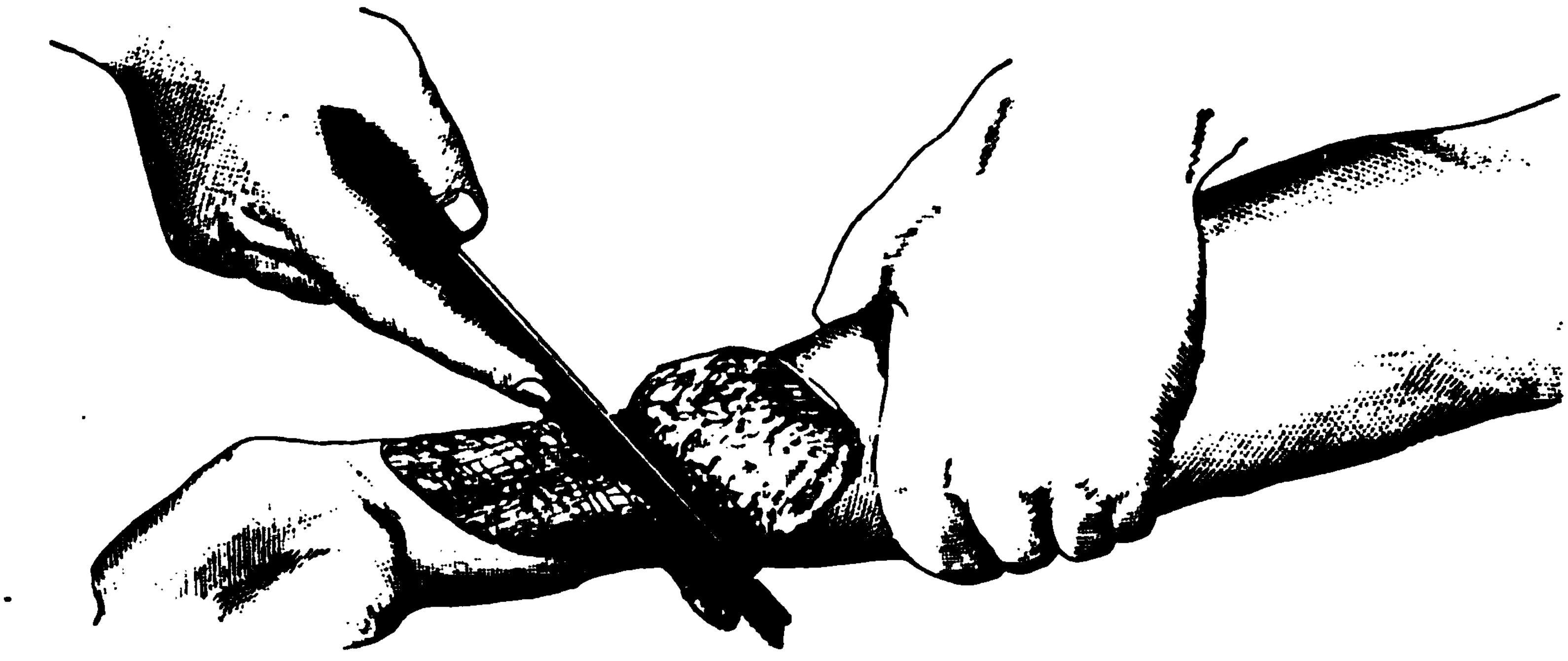
FIG. 41.



The brachial having been secured with an Esmarch's bandage, the arm extended from the side, with the forearm pronated and the hand steadied by an assistant, the surgeon, standing outside the limb on the right, and inside it in the case of the left side, places his left index and thumb on the borders of the radius and ulna, at the spot where he intends to saw the bones (Fig. 41). The point of a narrow-bladed knife (about 4 inches long), or a small catlin, is then inserted just below the index, carried along the bone for 3 inches, then curved suddenly across so as to mark out a broadly arched, not a pointed, flap (Fig. 42), an finally carried up along the bone nearest to the surgeon to a point just below the thumb.

This flap is then dissected up, consisting of skin and fasciæ, and of even thickness throughout.* The forearm is next raised by the assistant holding the hand, so that its palmar aspect faces the surgeon,† who marks out, by a curved cut joining the two horns of the other incision, a similar flap on the anterior surface, but one only about 2 inches in length. This flap having been raised and both retracted, the soft parts are divided with a circular sweep close to the base of the flaps, this being repeated once or twice till the bones are quite exposed. The knife is then passed, with due care of the severed arteries, between the bones, so as to divide the interosseous membrane, and the periosteum next cut circularly where the saw is to pass. The bones are then sawn through, with the following precautions:—The heel of the saw having been placed on the bones, it is drawn lightly, but firmly, towards the operator two or three times, so as to make a groove. With a series of light sweeps, in which the whole length of the saw is used, the two bones are then cut through together,‡ the limb being kept supinated during the use of the saw, so as to keep the bones as parallel as possible.

FIG. 42.



The assistant in charge of the lower part of the limb must be most careful to hold it steady: if he depress at all, the bones will certainly splinter when half sawn through; if, on the other hand, he raise the parts, the saw will be locked.

Any tendons requiring it are then trimmed, nerves cut short and square, and the vessels ligatured or twisted. These are usually four—viz., the radial, under cover of the supinator longus, close to its bone; the ulnar, covered by the flexor carpi ulnaris, on the front of the ulna. Their respective nerves are good guides to the arteries, save quite low down, when the radial has gone to the back of the limb. The anterior interosseous is found on the front of the interosseous membrane, and the posterior interosseous between the deep and superficial extensors.

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* The under surface of a so-called skin flap should always, when possible, show a few muscular fibres; this shows that the deep fascia is present, in which the vessels run down to send up branches to supply the skin.

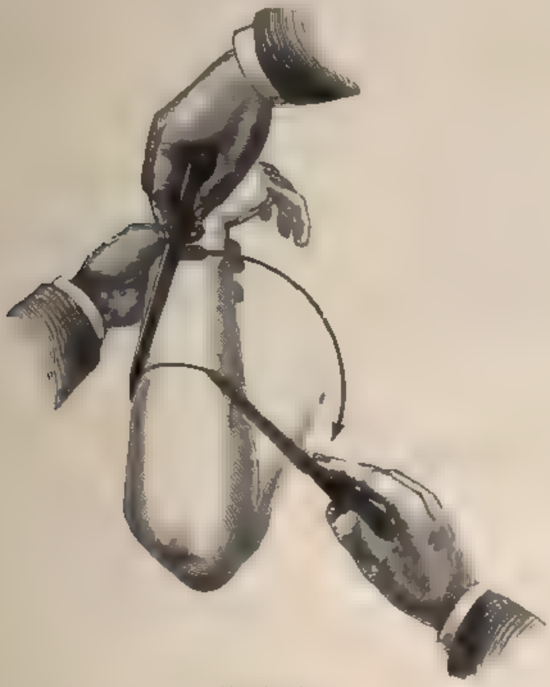
† Care must be taken to keep the bones parallel, now, and throughout the operation.

‡ Some advise that the more movable radius should be divided before the section of the ulna is completed. If the saw is used lightly and swiftly, both bones will be sawn simultaneously. The student usually commits these faults in the use of the saw—he bears too heavily on it, thus locking it or fracturing the bone, and he makes but short sweeps, using half of the instrument only.

If the surgeon prefer it, instead of having the forearm raised so as to face him (Fig. 43) while he shapes the flap from the anterior or flexor surface, he will tell the assistant to completely supinate the forearm, and proceed to make the flap with the limb in this position.

If, owing to the condition of the soft parts, **lateral flaps** are preferred, the limb having been pronated, the surgeon marks the site of bone-section with his left forefinger and thumb placed on the centre of the extensor and flexor aspects of the limb at this level. Then, looking over the forearm, he enters his knife in the middle of the flexor surface, and carries it, cutting a broadly arched flap, about 2½ inches long, to a corresponding point on the centre of the back of the limb, and then from this point down again over the side nearest to him, to the spot where the knife was first entered. The flaps are next dissected up with the precautions already given, and the operation completed as before.

Fig. 43

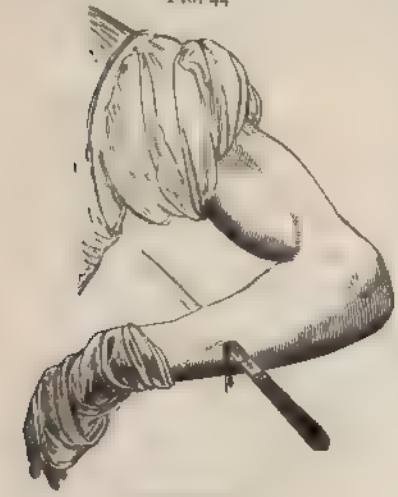


(Farabeuf.)

2. **Amputation of the Forearm by Transfixion Flaps** (Fig. 44).—In the case of a moderately muscular forearm the surgeon may make use of this method in amputating through the middle of the forearm. For reasons already given (p. 73), this method is not recommended, but the rapidity with which it can be done commends it to the notice of

those who may have to treat wounded in war on a large scale, or railway accidents where more than one limb requires amputation. The limb being abducted, and the forearm supported and pronated, with the bones as parallel as possible, the surgeon, standing outside the right and inside the left limb, lifts up the soft parts* at the spot where he intends to saw the bones, and sends a narrow-bladed knife (4 to 5 inches long) across the limb, entering it and bringing it out just above the bones. He then, by cutting downwards and forwards, shapes as broad a flap as possible with a steady sawing movement, taking care, before bringing out the knife, to cut the skin longer than the muscles by continuing the use of the knife after the latter are felt to be cut through. The flap should be 3 to 4 inches long, according to the condition of the tissues on the other side, each flap being made as broad as possible and bluntly rounded as it is finished.

FIG. 44



(Fergusson)

The tissues on the front are then lifted from the bones and transfixed by passing the knife across immediately above the bones at the base of the first-made flap, the limb being now supinated. As in this second transfixion the skin on the farther side of the limb may be punctured, it is well for the surgeon to hold down its cut edge with a finger. The second flap is then cut, broad, well-rounded, and 2½ to 3 inches long, according to the length of the anterior. In making either flap, while the muscles are being severed the wrist should be kept flexed. The flaps are then retracted, the soft parts severed with a circular sweep, the interosseous membrane divided, and the rest of the operation completed as in the method first described (p. 74). If this method is used the nerves should always be cut short and square; otherwise painful bulbous ends may follow.

A very rapid and effective modification of the above is the following: As, owing to the inequality of the soft parts on the back as compared with those on the front of the forearm, and also from the proximity of the ulna to the surface here, transfixion of a dorsal flap is not always easy, a quicker method is as follows:—A skin flap, 3½ inches long, broad and well rounded, being marked out on the posterior aspect of the limb, the knife is immediately, without being taken off, pushed across in front of the bones and made to cut a flap, by transfixion, 2½ inches long, the skin being cut longer than the muscles (*vide supra*). The dorsal skin-flap is then dissected up, the flaps retracted, and the bones cleared as before.

3. **Amputation of the Forearm by the Circular Method.**—This

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* This step is most useful—in fact, essential. It is often forgotten.

method is not recommended here owing to the flat shape of the limb and the adhesion of the deep fascia above to the muscles. It is best suited to amputation in the lower third. It may be performed as follows:—The surgeon, standing outside the limb, which is kept supinated, having drawn the skin well upwards, passes a knife under the forearm, then above, and so around it till, by dropping the point vertically, the back of the knife looks towards him, and its heel is resting on the part of the forearm which is nearest to him. An incision is then made circularly through skin, superficial and deep fasciæ,* round the whole circumference of the limb, 2½ inches below the point where the bones are to be sawn. The completion of this circular sweep is aided by the assistant in charge of the limb rotating it so as to make the tissues meet the knife. The forearm is supinated at first, but may be pronated later, while the cuff is being dissected from the posterior surface.

A circular cuff-like flap of tissues having been turned back as high as the point of bone-section, a second and much firmer circular sweep is here made through everything down to the bones, this being repeated till all the soft parts are cut clean and square. If there is any doubt about the sufficiency of coverings to the bones, the soft parts around these may be freed a little higher (care being taken not to prick the radial or ulnar); the soft parts are then vigorously and firmly retracted, and the bones sawn through, with the precautions given at p. 74.

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* If, in raising the cuff-like flap, muscular fibres are seen on the under surface, the presence of the deep fascia and, thus, a sufficient blood-supply will be better assured than by the quicker method of simply peeling the skin and subcutaneous tissue off the deep fascia.

CHAPTER IV.

OPERATIONS IN THE NEIGHBOURHOOD OF THE ELBOW-JOINT.

AMPUTATION AT THE ELBOW-JOINT (Figs. 45, 46).

THIS operation gives excellent results, good flaps being obtainable from the thick soft parts in front, and from the skin behind which is well used to pressure. Furthermore, there are no bones to saw.

It has not been performed so often as it might have been, owing, perhaps, to the belief which some surgeons have held that cartilaginous surfaces left in a wound are a source of delay in healing—an opinion no longer of importance in antiseptic surgery; from the fact that any disarticulation, however simple, is considered to complicate an amputation; and because, owing to the expanded end of the humerus, the flaps required are somewhat larger than in amputation through the lower third of the humerus.

Practical Points.

(*a*) The internal condyle is nearly ½ inch below the level of the external. (*β*) The joint is opened most easily on the outer side. (*γ*) There are masses of muscles on the front and sides; of the latter, those on the outer side (owing to the presence of the supinator longus) retract more powerfully than those on the inner. (*δ*) The skin on the back of the joint is well used to pressure, and is connected by fibrous bands to the back of the ulna.

Methods.—Owing to the vascularity of the parts, any of the following may be made use of. I would advise the student to practise the first especially.

i. Long anterior flap with short posterior (Figs. 45 and 46).
ii. Lateral skin flaps, or a single lateral flap.
iii. Circular.
iv. Long posterior flap.
v. Long anterior flap.

i. **Long Anterior Flap (usually by Transfixion) with Short Posterior Flap** (Figs. 45, 46).—This method gives an excellent covering to the front of the humerus, allows of easy drainage, and preserves skin which is well used to pressure.

The brachial being controlled a little above its centre,* the forearm being held somewhat flexed and completely supinated, the surgeon, standing on the inner side in the case of the left, and outside the right limb, raises the soft parts in front of the elbow-triangle, and sends his knife, held horizontally, across, just in front of the joint. Thus, entering it 1 inch below the internal condyle, and bringing it out 1½ inch below the external one, or *vice versâ*, he cuts a well-rounded flap, 3 inches long, taking care, as the knife emerges, that the skin is cut longer than the muscles. Then, passing his knife behind the limb, and looking over, the surgeon joins the two ends of the base of his first incision by a convex cut through the skin over the back of the olecranon, so as to mark out a flap 1½ inch long. This is raised without scoring, care being taken to keep the knife towards the ulna, for fear of "buttonholes." The two flaps being then held back, any remaining structures in front are severed, the joint is first opened on the outer side, and the forearm removed by dividing the lateral ligaments and triceps.*

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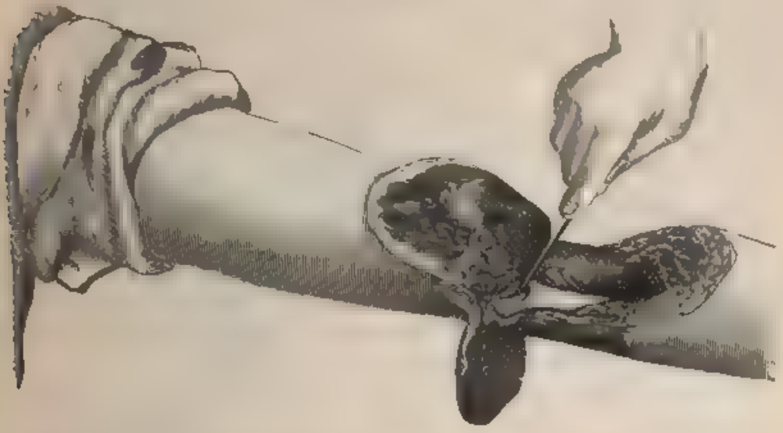
* The assistant who has charge of the Esmarch's bandage, and who is steadying the arm, should draw the skin on the back of the elbow-joint somewhat upwards.

FIG. 45.



Amputation through the elbow-joint by anterior and posterior flaps, at the moment of disarticulation.

During the last steps the assistant in charge of the forearm pulls this away from the arm.

The brachial artery is next secured, together with any other vessels which continue to bleed on removal of the Esmarch's bandage. Any nerves which require it are then cut short, a drainage-tube inserted, and the flaps carefully united.

Modifications of the Above.—The flaps can be cut of different lengths, according to the state of the soft parts. If the surgeon prefer to do so, he can cut his anterior flap from without inwards instead of by transfixion, a course which may well be adopted in an unusually bulky, muscular limb. The posterior flap can be made by cutting from within outwards, after disarticulation, but this, while quicker, is usually not preferable.

ii. **Amputation by Lateral Skin Flaps, or by One Lateral Flap.**—

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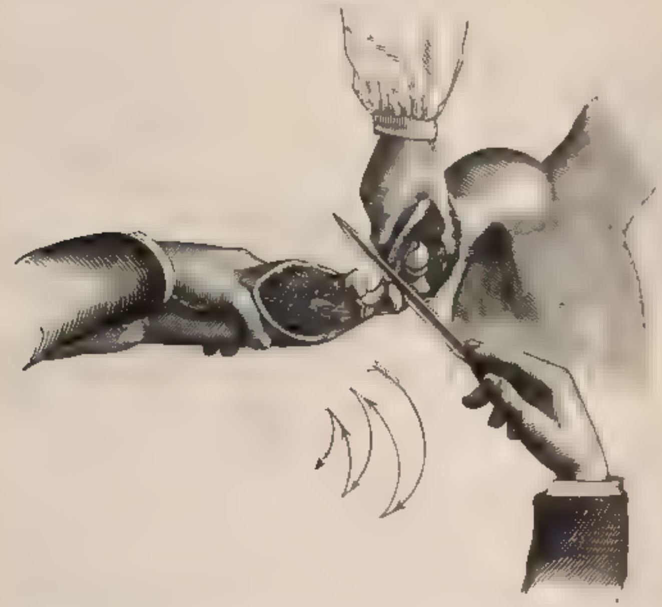
* In Fig. 45, by mistake, the operator has been shown commencing disarticulation on the inner instead of on the outer side, which is usually the easier. The flaps also are rather too long. For these errors I alone am responsible.

The advantages of this method are, that it is very easily done, and that, if more skin is available on one side than on the other, flaps unequal in length can readily be made. If the surgeon amputate by equal lateral flaps, standing as before, and having his left index finger on the centre of the elbow-triangle and left thumb at the corresponding point behind, he looks over, and entering the knife close to his thumb, marks out, on the side farthest from him, a flap well rounded, and about 2½ or 3 inches long, reaching to the finger in front. He then marks out a corresponding flap from this point, on the side nearest to him, to that where he began. These flaps are then dissected up of skin and fasciæ as thick as possible, the soft parts severed with a circular sweep, and disarticulation performed, beginning at the outer side.

Fig. 46



Completion of amputation through the elbow joint by anterior and posterior flaps. The arrows indicate the saw-like action with which the knife should be used. (Farabeuf.)

iii. **Circular Method.** The surgeon, standing as before, makes a circular incision round the forearm, 2½ or 3 inches below the joint, going through skin and fasciæ. A cuff of skin is then turned back as far up as the joint, the muscles severed with one or two firm sweeps, the lateral ligaments divided, and disarticulation performed as before. The edges of the wound may be united either horizontally or vertically from above downwards.

EXCISION OF THE ELBOW (Figs. 47 to 52).

Practical Points. These bear upon the success of this operation.

(1) It is a comparatively simple joint, with small articular surfaces readily got at. (2) Its synovial membrane is simple. (3) Its vascular

supply is abundant. (4) The surrounding muscles are powerful, ensuring, if they regain firm attachment, excellent mobility. From the above, and from the untoward effects of ankylosis, a natural cure in the elbow is, often, not so useful as that given by excision. This operation should be performed oftener, especially in the first six of the following conditions:

Indications.

(1) Pulpy disease. Where this has resisted treatment in a patient who shows no sign of tuberculosis, lardaceous disease, &c., where it is the only large joint affected, and where the powers of repair are sufficient. If treatment fails to promise a movable joint, there is no good losing more time; the muscles will only be more wasted, sinuses will only form more extensively, and the patient's health be more impaired. (2) Recent injury and its results. (A) *Primary Excision.*—When the joint is much opened, the cartilages much damaged, when the shaft is intact* and the tissues in front are sound, an excision may be preferable to expectant treatment. If aseptic from the first the operation excludes the risk of acute arthritis, and its certain sequela, a stiff joint. But here. as in excision for disease, the determination and pluck of the patient will be most important factors. And the age of the patient's tissues and organs will have much more weight than the age given, in the decision between excision and amputation. (B) *Secondary Excision.*—When acute arthritis, not yielding to incision and drainage of the joint, has followed on an injury, and ankylosis is the best result which can be hoped for without operation. In such cases, as the inflamed condition of the bones and soft parts may produce septic cellulitis and osteomyelitis after an operation, it will be wiser, before excising, to wait till the inflammation has somewhat subsided. It must be remembered that, in excision after injury, reaction will probably be greater, suppuration more certain, and a tendency to bony ankylosis more marked, especially if the periosteum is preserved. Sufficient drainage is absolutely needful. (3) Old injuries to the elbow-joint, resulting in stiffness, ankylosis, or, more rarely, pressure on the main vessel or nerve trunks. I hope the following may be useful to my younger readers when the questions arise in such cases, whether we should interfere, and, if so, how far we should go. i. Operative interference is justified in cases where the patient is otherwise healthy, and where his future will be seriously crippled. ii. As to the nature of that interference. (A) *Forcible Movement under an Anæsthetic.*—This, often resulting in the "infraction" of some American surgeons, is not to be recommended. The results are rarely good, may be *nil*, and may be followed by serious damage (Wight, *Ann. of Surg.*, Aug. 1893). Where the needful forcible movement is painful and followed constantly by swelling, the patient must decide between a complete excision, performed on liberal lines, and having the limb put up in a fixed position, at an angle as acute as possible.† (B) *Arthrotomy.*—Opening the joint, division of adhesions, attempted reduction of the displaced bones with the fingers or a blunt hook, will

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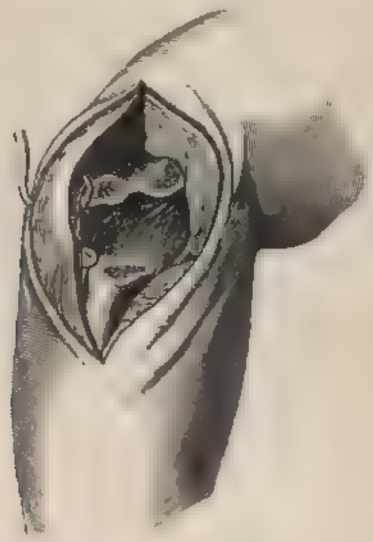
* Linear fracture, running up into the shafts of the bones, may be neglected, as in the case given below (p. 83).

† If plaster of Paris be employed, the bony points—*e.g.*, the condyles—must be carefully padded.

be found a step of very limited usefulness. (C) *Partial Excision.*—This course has been recommended by several American surgeons. Thus, Dr. Wight, of Brooklyn (*loc. supra cit.*), gives four cases of stiff elbow after fracture, in which he removed the lower end of the humerus by an incision made over this bone and the head of the radius. The results would appear to have been satisfactory, but the exact degree of success is not stated. I am of opinion that those same conditions, which, after an injury to the elbow-joint, may interfere with any good result from forcible movement, will also interfere with success after partial excision. I refer to development of osteoid masses in stripped-up periosteum, displacement of part of the torn capsule between the joint surfaces, filling up of the articular cavities with fibrous tissue, deformities at one or more points in the joint owing to overgrowth of the epiphysial line, and lastly, perhaps, ankylosis between the radius and ulna. Some of the above—*e.g.*, the formation of osteoid deposits—will be specially marked in young subjects. Here, owing to their marked reparative power, and the inflammation set up by the injury, the tendency to secondary ankylosis is so great that it will best be met by a free removal of the bony surfaces. Partial excision risks a result of incomplete value—*i.e.*, a joint of limited movement, though one, perhaps, with a useful angle. Where there has been no suppuration and but little

FIG. 47



The hook in this illustration shows the continuity of the outer head of the triceps with the fascia over the anconeus (Maunder).* Too much of the posterior aspect of the ulna has been cleared.

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* *Operative Surgery.* Maunder was the first in this country to call attention to the need of preserving the continuity of the triceps with the above-mentioned fascia in order to ensure the return of the power of active extension.

inflammation, where the cartilages are not damaged, where there is no fracture present of the articular ends, the surgeon may try in a case of old injury to the elbow-joint—*e.g.*, an unreduced dislocation of both bones backwards,—first, sawing off the articular end of the humerus, the section being supra-epitrochlear (p. 89). If he find that after this step he can place the hand on the shoulder of the same side, and behind the back to the opposite scapula, with perfect freedom and without any locking, he may be content to leave the extremities of the ulna and radius untouched, if his patient be an adult. But if the above given conditions are not present, and most especially if there be any separation of part of an epiphysis or process of bone, ripping up some periosteum which has ossified later on, and in all cases in children, he will only secure a movable joint by a complete excision with sufficient removal of bone (p. 89). The following is, very briefly given, an interesting case of excision of the elbow for an old dislocation and fracture:

M. E. W., aged 28, was sent to me in February 1894, by Dr. E. Davies, of Swansea. The injury, received the previous November while he was riding over a sheep-farm in Tierra del Fuego, had never been treated. A dislocation backwards of both bones of the right elbow-joint was typically evident, and in addition there was distinct shortening of the humerus, marked coldness and lividity of the hand, and deficient radial pulse. The limb was fixed at a very obtuse angle, active and passive movements being almost completely abolished. During the excision it was found that a fracture ran obliquely from without inwards through the lower third of the humerus. When the limb was placed in the extended position after the operation, there was still a full 1¼ inch between the bone-ends. Healing was uneventful. At the end of four months the patient, a man of undaunted pluck and imperturbable temper, could use the arm to play lawn-tennis, shoot rabbits with a rifle, and ride. Five months after the operation, extension and pronation were practically complete, flexion was full enough to allow of his touching his right ear and buttoning his collar-stud with the right hand, but not sufficiently perfect for him to touch his right shoulder. Only about half the full range of supination was present. In 1895 the patient wrote, saying, "My arm is as useful to me as it was before the accident. I can shear sheep, ride, and shoot with any man." August 29, 1899, he writes. "This morning I stood in one place and shot six Brent geese coming over, with seven cartridges."

(4) Some cases of injury to the lower epiphysis of the humerus. In the majority of cases, judicious treatment, including, especially, the early examination and reduction of the displacement, *under an anæsthetic*, the putting up of the elbow at a useful acute angle with plaster-of-Paris splints* or flexible metal splints (Poland, *Traumatic Separation of Epiphyses*, p. 385, Fig. 99) will suffice. In a certain number more will be required. Such cases fall under the following heads: (A) *Compound Injuries.*—Here an excision on free lines is more likely to bring about a good result than the expectant method, especially if the suppuration be septic. (B) *Simple Injuries.*—Excision will be the wisest step here in cases where, four to eight weeks after the accident, the joint remains stiff, at a useless angle, where the ankylosis is clearly intra-articular, not muscular, and where the breaking down of adhesions is constantly followed by recurrent inflammation, pain, swelling, &c. And

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* If this simple and efficient method were more frequently used, an anæsthetic being given and care taken to pad all points where pressure is likely to fall, the after-results of these cases would be greatly improved.

the operation will be additionally indicated where ankylosis is largely due to osteoid deposits in stripped-up periosteum or to a portion of detached epiphysis, *e.g.*, the epicondyle, having been wedged in between the trochlea and sigmoid cavity, and thus rendering improvement of the position impossible from the first. I am of opinion that in all these cases an excision, to be successful, should be conducted on free lines; that if the surgeon leave the articular surfaces of the radius and ulna he should remove the lower end of the humerus very freely (p. 89); that he should be very careful in testing the freedom and smoothness with which the hand on the affected side can be put through certain needful movements (p. 89). Mr. Poland—in his book, which is a mine of wealth of information, given in the clearest possible way, on subjects often dry and abstruse—is against complete excision in these cases. While I admit that no opinion stands higher than his, my own experience would lead me to recommend it in such cases as I have alluded to above. I am well aware that complete excision in young subjects may lead to a limb shortened by two or three inches, but a shortened upper extremity is of little moment if the hand is rendered thoroughly useful by a mobile elbow-joint, and many besides myself have had abundant experience of the frequency with which ankylosis follows, in these cases of injury to the lower epiphysis of the humerus not excised on sufficiently free lines, owing partly to conditions already alluded to, and partly to the great difficulty of getting young patients to give any assistance in the needful movements of their joint.

(5) Ankylosis in a faulty position. The following are the chief points which will present themselves for consideration:—How far the angle is an obtuse one, and the position of the limb such as to render it useless; the age and vitality of the patient, and his interest in possessing a mobile joint; the condition of the muscles (for if the ankylosis be of long standing these may be so utterly atrophied that the usefulness of the limb will be but little increased by operation); the co-existence of any cicatricial bands, especially in front, which will interfere with the after-result. A bilateral ankylosis, especially at useless angles and in young subjects, calls urgently for resection, the operations being performed at an interval of about four weeks, and the limb in which the muscles are least wasted being taken first, so that a good result may encourage the patient. The more complete the ankylosis, the more the articular surfaces are fixed throughout (*i.e.*, not at one spot only—*e.g.*, olecranon tip to olecranon fossa), the greater the thickening of the periosteum, the more are osteoid nodules or spicules found scattered about in the ligaments, the more freely must the bones be removed. Further, in all cases of bony ankylosis, the surgeon should examine into the state of the superior radio-ulnar joint, or an ankylosis here may be overlooked after the main disease has been treated. (6) Disorganising arthritis of elbow after one of the exanthemata, pyæmia, or rheumatic fever. (7) Osteo-arthritis. If the patient is healthy, not advanced in years (*i.e.*, not much over forty) and not broken down, and if this is the only joint attacked: the surgeon must be prepared for sawing very dense bones here. (8) For growths of the bones, especially if innocent and affecting one bone—*e.g.*, exostosis.

The following points call for consideration in any case where excision of the elbow is being discussed:

1. *Age.*—This must always have much influence. In very young children due attention must be paid to the naturally great power of repair. After thirty-five or forty the surgeon should weigh very carefully all the points of the case, and only excise where all else is favourable. From puberty to thirty-five I consider the best age. Those who see much of the surgery of childhood will, of course, be called upon to decide upon the operative treatment of tubercular disease of the elbow-joint at a much earlier date. During the first three or four years of life resection is not to be recommended. This is partly due to the fact that, owing to the greater tendency to repair, less severe steps—*e.g.*, curetting, removal of tubercular foci of osteitis and caries—will often be sufficient, but partly, as far as my own experience goes, because the surgeon will be driven to hold his hand on account of the feeble, miserable condition of those patients with tubercular disease of a large joint so early in life. Owing to the difficulties, inevitable during the after-treatment, in carrying out active and passive movements, the surgeon must be careful to place the limb, from the first, at a useful angle. After the age of four, the patients, owing to their increasing vitality and resisting power, are better fitted for resection, but the activity of the periosteum, together with the fact that it is impossible to rely upon the patients for any help in active mobilisation of the joint, calls for free removal of bone.

2. *Complications.*—These are most likely to present themselves in the shape of diseases of other bones and joints, for such a complication as phthisis calls for amputation. Caries of the metacarpal or metatarsal bones is not of itself a contraindication. If a diseased spine is present the question of excision will depend on whether the vertebral caries is old, or recent and active. If old, is the elbow a source of much irritation? Two large joints are rarely diseased at the same time. Mr. Holmes (*Clin. Soc. Trans.*, vol. i. p. 143) records a case of a boy, aged 5, where he excised, with excellent results, both elbow-joints—only a few weeks intervening between the two operations. Mr. Clement Lucas (*Brit. Med. Journ.*, 1881, vol. ii. p. 897) relates a case in which disease of the left elbow came on about two years after excision of the right joint, and was also successfully operated on. Since 1886 I have excised the elbow-joint with good results in four children, in whom some years before I had successfully excised a knee-joint. And in one of the four I had, later on, to remove a tubercular tarsus by a Syme's amputation. When this child was seen a year later, all three operation-wounds were sound. The new elbow-joint was a very useful one.

3. *Question of the Value of Preserving the Periosteum.*—While the periosteum may be easily preserved in cases where it is swollen and loose, its preservation is in others a matter of very great difficulty, rendering the operation much more laborious and prolonged,* and it is extremely doubtful if its advantages are equivalent in this joint, where the ordinary operation gives such excellent results. Some cases—*e.g.*, primary excision for injury—are unsuited to this method, as the unaltered periosteum is most difficult of removal from the irregular bone ends. In tubercular disease it is often unsuitable on account of the risk of leaving mischief behind.

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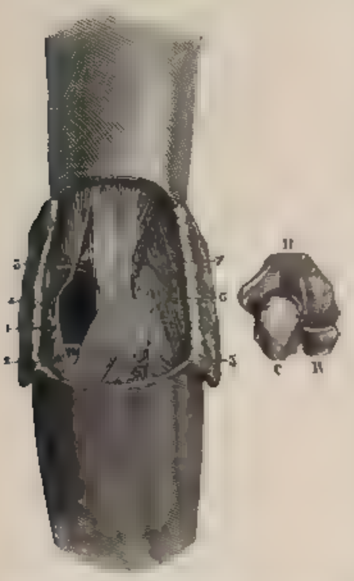
* In the case of excision of the shoulder-joint (p. 166) the conditions are very different.

Subperiosteal resection is said to lead to less hæmorrhage, less disturbance of the capsule and attachments of muscles, with greater lateral steadiness and completeness of the new joint. While the last of these is undoubted, it may bring about impaired movement,* and I am of opinion that the surgeon should only trouble to preserve the periosteum, while clearing the lower end of the humerus of its important muscular attachments, especially in cases where an unusually large amount of bone has to be removed. If the periosteum is kept, the removal of the bone will be additionally needed.

FIG. 48.



Right elbow after excision of the joint by the usual posterior incision. (Farabeuf.) 1 and 4, Cut edges of the outer expansion of the triceps tendon. 2, Ulna. 3, Humerus. 5, Anconeus, covered by 6, Outer expansion of triceps. 7, Supinator longus and radial extensors of the carpus. To the right the bones removed during the operation are seen. The humerus has been sawn through at a point somewhat higher than usual.‡

Operation. The single vertical incision at the back gives such excellent results that this operation will alone be fully described. An Esmarch's bandage having been applied over the upper arm, or the whole limb being rendered evascular as far as the above point by the use of two bandages, the limb is flexed and carried over the front of the trunk, so as to present it fairly to the surgeon, who usually stands on the opposite side of the body.

The surgeon, then, noting the relative position of the condyles and the course of the ulnar nerve, makes a straight incision of sufficient length† (three to four inches in the adult), with its centre at the tip of the olecranon, a little internal to the centre of the back of the joint, and parallel with the ulnar nerve. This incision should begin above or

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[*] A case is given (Langenbeck, *Arch.*, vol. viii, p. 136) in which, after subperiosteal resection, the condyles had been very perfectly reproduced, and the olecranon had been re-formed to even an inconvenient extent, for it was so long and curved as somewhat to limit extension. This method should usually be rejected in children, and also in cases of ankylosis, for fear of a recurrence. The candid Prof. Ollier, with all his experience, writes (*loc. supra cit.*, p. 218), "Aussi, après une resection sous-périostée, est-ce la roideur qui est plus à craindre que la trop grande laxité."

[†] An insufficient incision will only increase the difficulty of the operation, and, by the bruising then consequent upon the strenuous use of retractors, lead to suppuration.

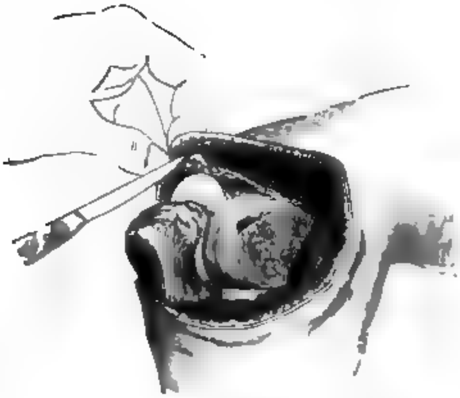
[‡] One of the leading surgeons in London, a former President of the College of Surgeons, who has provided me with some kindly criticisms of this book, has urged me to abolish this drawing, on the ground that removal of so much bone would inevitably reject any candidate. I have warned my readers above that rather too much of the humerus has been shown removed, but as I am convinced that restricted movement is far too common after this excision, owing to too limited use of the saw (p. 88), I venture to retain the illustration.

below as is most convenient, and go down to the bone throughout its whole extent, splitting the triceps muscle and tendon. Partly with the point of the knife, partly with a resection-knife or elevator * (Fig. 52), the surgeon then raises, as far as possible in one piece and without tearing or jagging, the outer half of the triceps, which, with its expansion into the deep fascia of the forearm over the anconeus (Figs. 47 and 48) —this latter muscle being taken up at the same time,—is peeled up as thickly as possible from its insertion into the ulna. It is on the preservation of this expansion that the regaining of active extension will depend.

I may here say that resection-knives and elevators of the French pattern (Fig. 52) are the best. A glance at Fig. 52 will show this to any one who is familiar with the difficulties of an excision on a powerful adult for an injury or after ankylosis.

The deeper parts on the outer † side of the joint are then separated from the bones with the elevator, or knife, and thumb-nail, until the external condyle and head of the radius are completely exposed. The left thumb, all the time sunk deeply into the wound, pushes the flap of soft parts, as it is detached, towards and over the external condyle. It is, finally, displaced over this, as the joint is flexed strongly. Next, the parts on the inner side should be detached from the inner condyle and inner border of the olecranon, great care being taken, by the following precautions, to keep intact the ulnar nerve :—(*a*) By keeping the knife parallel with the nerve and close to the bone; (*b*) By the use of the

FIG. 49.



To show the level to which the bones are to be cleared, and the way in which the thumb-nail is kept between the knife and the soft parts.

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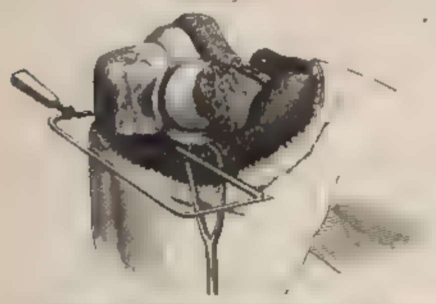
* Unless the tissues are softened by inflammation any "blunt dissectors" are useless. Any periosteal elevator—*e.g.*, the one shown in Fig. 52—should have a distinct cutting edge. When such are not to hand I prefer a pair of scissors curved on the flat. They make an efficient periosteal elevator, and at the same time afford a cutting edge whenever this is needed. If the knife be used each cut should be short, and, as it is made, the edge must ever be kept turned towards the bone.

† For the sake of practice, it is well to take the outer side first, before clearing the inner, with the ulnar nerve in proximity to it.

thumb-nail, which peels off the soft parts before the knife. By these means the soft parts will be satisfactorily cleared from the bones; retractors (Fig. 53), well applied, will be found most useful, as the process of peeling off the soft parts is somewhat fatiguing to the thumb. This is especially the case in excision for accidents or on the dead body, and it is in these only that the nerve may be seen, though indistinctly. Where the parts have been long inflamed, they peel off much more readily and the nerve is buried in the swelling.

The clearing of the soft parts of the bony prominences will be much facilitated by keeping the joint extended as much as possible, and the soft parts thus relaxed.

FIG. 50.



To show the application of the saw. The dotted line across the humerus passes well above the articular cartilage, but is not high enough (p. 89).

Each lateral ligament, if this has not been already done, is raised, together with the periosteum and the group of flexors or extensors respectively, freed from and pushed over the condyles, and there retained with retractors.

The joint is now strongly flexed, and the capsule opened just above the olecranon. Mr. C. Heath (*Operative Surgery*, p. 101) advises that at this stage the olecranon process be grasped with lion-forceps and sawn off, or, in young subjects, cut off with bone-forceps, as this step "opens up the joint most satisfactorily and saves the trouble of dislocating the ulna." The bone ends are then turned out and prepared for the saw by passing the knife down to the bone, along the lines of intended section, the soft parts being well retracted beyond these lines. In turning out the bone ends it is easy, in patients where the parts are delicate or softened by inflammation, to strip off a needless amount of periosteum—*e.g.*, on the anterior aspect of the shaft of the humerus.

SITE OF BONE SECTION.[*]—The ulna should be sawn (from behind forwards, with a small Butcher's saw set firmly), so as to remove the greater and lesser sigmoid cavities with the olecranon. The radius is removed at the same time just below its head, above the biceps. Before this is done, the assistant who is holding the forearm should thrust the ends of the bones prominently but carefully (*vide supra*) into the wound. The section of the humerus requires careful attention. An insufficient amount is usually removed here, and limitation of subsequent movement thereby invited. It is generally considered sufficient to remove all the articular cartilage, the section being made to pass through the lower part of the coronoid and olecranon fossæ, and below the level of the epitrochlea on the inner, and through the epicondyle on the outer, side. This is not enough.[†] The saw should pass at a higher level, *i.e.*, above the level of the epicondyle, and through the highest part of the epitrochlea, removing quite the lower two-thirds of this process. This is the very lowest level at which the surgeon should hold his hand if he desire to obtain good movement.* And before he is satisfied on this point he should place the fingers of the affected limb not only on the opposite shoulder and the mouth (as is often done), but on the shoulder of the same side, and behind the back to the angle of the opposite scapula. Unless these movements are perfectly free, he should take another thin slice off the humerus, removing the whole of the epitrochlea. This step may seem to my younger readers a needless shortening of the limb, and likely to lead to a flail-joint. I can assure them that it is not so. As long as the elbow-joint is freely movable. shortening of the bones matters very little. If attention has been paid to the advice given at p. 87, and the soft parts separated very carefully and, as far as possible, subperiosteally from the epicondyle and epitrochlea, the joint will become sufficiently steady laterally as well as freely movable although these bony prominences have been freely removed. Another test which the surgeon should always apply before considering the section of the bones completed is the interval between the sawn ends. Prof. Annandale (*loc. supra cit.*) considers that 1½ inch should intervene between them when the bones are extended. This will be none too much in adults, especially in cases where, owing to the condition of the parts, recurrent inflammation is certain. In all cases (and this is especially so in those of ankylosis† where a recurrence of the trouble is to be dreaded) more bone must be removed from the humerus than from those of the forearm. where the section is limited by the attachment of important muscles. Mr. Holmes has pointed out, long ago, that if, after removing as much bone as is wise, disease is still felt upon the anterior surface, it is not necessary to make further sections so as to get beyond it; thorough curetting will be sufficient, and will save any further interference with the attachments of muscles. While the bones are sawn, the olecranon and trochlea of the humerus may be steadied in the grip of a lion-forceps, the soft parts at the sides being well retracted.‡ Any soft, caseous patches in the bone ends are now gouged, any possible sequestra removed. In bad cases the bones are liable to be fatty, with little natural marrow; such, however, are not necessarily irrecoverable. If the bone above the levels of section appears roughened, and the site of periostitis, this need not be touched; all will probably subside when the cause of irritation is removed. Any sinuses or suppurating pockets should next be laid open, with due regard to the ulnar nerve, and their contents scraped out with sharp spoons. Iodoform emulsion and tampons of iodoform gauze should be inserted, partly for the arrest of hæmorrhage, and partly (in tubercular cases) to promote healthy granulations. One or two points of suture may, perhaps, be inserted, so as to close just the ends of the wound; but all the rest of this should be left open, and a drainage-tube inserted in cases where there is much oozing or where septic sinuses have been present.* Very varied forms of splint have been advised.† Some surgeons, to keep the bones apart, from the first put the limb up on some form of right-angled splint; others, fearing a flail-like condition of the joint, prefer to begin with the arm and forearm on a straight splint, or on one with an obtuse angle (about 135°—Ashurst, *Encyclopædia of Surgery*, vol. iv. p. 477). As ankylosis is, in children especially, to be dreaded (*vide infra*), I much prefer to put cases up from the first on a right-angled splint, using some such cheap form as that which I have described in the *British Medical Journal*, 1877, vol. i. p. 774, in which the anterior metal bar supports the limb, while it leaves the wound and its vicinity well exposed and is easily kept clean, both parts being easily boiled in a steriliser; moreover, the movable hand-piece readily admits of some early passive pronation and supination. The objection to this splint is that it does not give quite enough support to the limb. Prof. Volkmann's (based on that of Prof. Nathan Smith for the lower extremity), Prof. Esmarch's, and Prof. Ollièr's (Fig. 51), all of wire and easily bent, are better in this respect, and all admit of the limb being slung—a great relief to many patients during the first week or so, this position also readily showing whether any discharge has made its way through the dressing. If plaster-of-Paris bandages are used to secure the splint, they should be left off as soon as possible owing to their cramping effect upon the muscles. Wooden splints should not be employed. They are not easily sterilised, they do not admit of alteration of the position and angle of the joint, and anterior angular splints are always dangerous in children owing to the delicacy of the tissues on which the splint exerts most pressure.

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[*] See the remarks below on the amount of bone to be removed (p. 89).

[†] If only half an inch of the humerus be removed, together with the head of the radius and the olecranon process—the latter perhaps obliquely—ankylosis is certain.

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* M. Ollier (*Traité des Résections*, t. ii. p. 203) usually makes the section at a much higher point than most surgeons. He first states that the section of the humerus may be made at different levels—(1) That which removes the articular surface only, the sub-epitrochlear; (2) That which passes through the substance of the epitrochlea, the intra-trochlear; (3) That which passes just above the epitrochlea, the supra-epitrochlear; (4) That passing through the shaft. He then goes on to say, "The section most frequently made—that which is indicated in the majority of cases of chronic joint disease, whether in young or old subjects—is the section above the epitrochlea," *i.e.*, number (3).

† In cases of bony ankylosis, it is well, before attempting to make sections of the bones, either to break down the union forcibly (care being taken not to fracture the possibly atrophied bones above and below, or to separate any of the epiphyses); or, better, to divide the ankylosis with a saw, chisel, or osteotome.

‡ Mr. Heath thinks (*loc. supra cit.*) that "the ulnar nerve is more in danger of being cut with the saw when the ulna is divided than when the section of the humerus is made, it being more difficult to clear the former bone."

Passive movement of the fingers and wrist should be begun on the second or third day. The joint itself should be moved as soon (but very gently and slightly) as all irritation has entirely subsided and the deeper part of the wound is firmly healed—about the twenty-first day; this date varying according to the size of the gap left between the sawn bones, the probable condition of the tissues as to inflammatory exudation, &c. In children an anæsthetic may have to be given several times. The angle of the splint should be altered or the limb put up straight for a few days, and then flexed. Later on, weight-extension should be used, by securing a bag of shot, which is added to from day to day. Later, the sound limb may be fastened up, so that the child must use the excised joint. But when these aids have to be resorted to, the result will often be imperfect. The surgeon should put himself on the safe side by ensuring, originally, a sufficient gap between the bone ends when he uses the saw.* The best test of the future usefulness of the limb is that the first passive movements are free and almost painless. The getting children to use the joint is often most difficult, as friends are usually too foolish to see that the surgeon's directions are carried out daily, because they cause a little brief, but most necessary, suffering. Parents are far too ready to think that because an operation has been performed, and the wound nearly, if not quite, healed, no more is necessary.† In commencing pronation and supination early, the ulna should be steadied while the hand and radius are very carefully moved. The first attempts at passive movement should be exceedingly gentle, and too much should not be attempted at first. I am aware that the date above given for the commencement of passive movement is later than that often taught—*e.g.*, about the tenth day. Nothing will be lost, but much gained, by giving the parts the longer rest. If the surgeon pictures to himself what is going on under the skin he will recognise that every time early passive movements are practised, the uniting structures, as yet richly cellular with vessels of embryonic tissue, are injured, and fresh exudation and hæmorrhage follows, which must all be absorbed or organised. When the parts are sufficiently firm the splint may be left off and a sling substituted. Falls must be carefully avoided, and no liberties taken with the new union—*i.e.*, by a patient attempting to do too much with the limb as in lifting. Later on, when an increasing range of movements may

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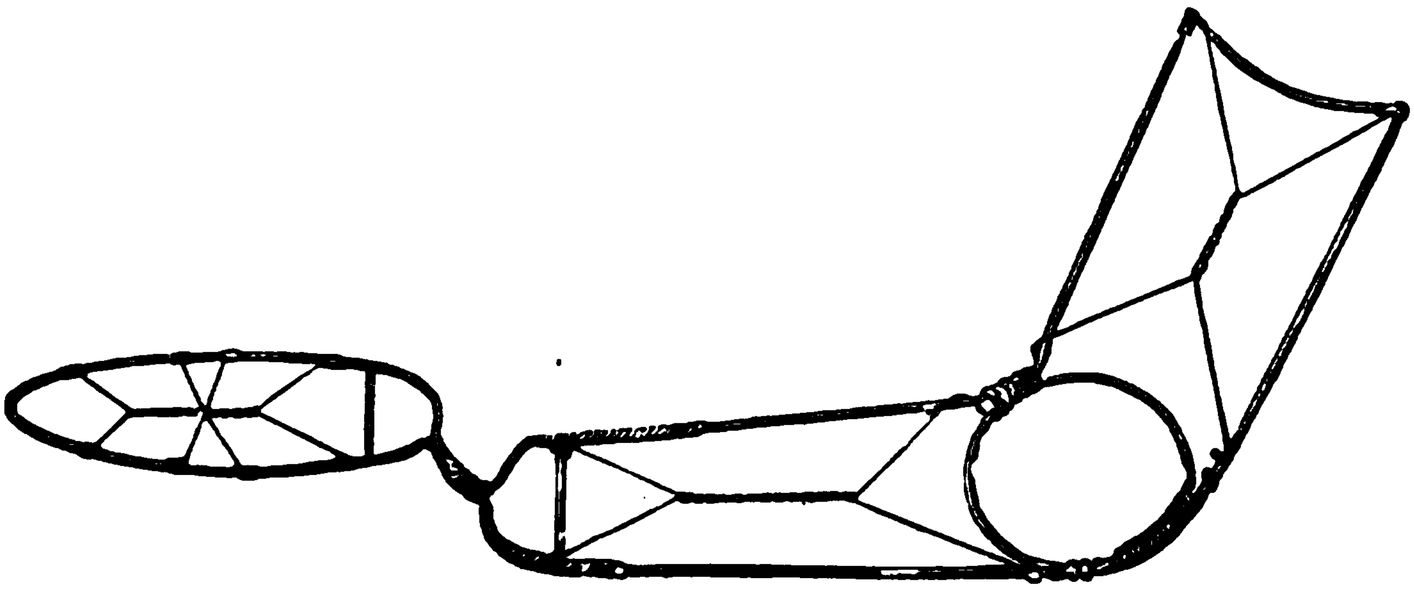
* Farabeuf (*Man. Opér.*, p. 710) points out that if, owing to long-existing disease of the elbow, the shoulder, wrist, or fingers are stiff, opportunity should now be taken to break down adhesions.

† By some surgeons a splint is here dispensed with. I strongly advise the use of one which is light and simple (*vide supra*), especially in children, as, during the first two weeks, where a splint has been dispensed with, the bone ends have been known to project from the wound.

FIG. 51.



Esmarch's wire splint for excision of left elbow. The supine position of the hand, which it is important to preserve, is well maintained in this splint. Plaster-of-Paris bandages may be used. The splint can be bent to any angle. (Mac Cormac.)

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* Mr. Whitehead (*Brit. Med. Journ.*, 1872, vol. ii. p. 554) records the case of an adult in which 2½ inches of the shaft of the humerus had to be removed after sawing off the condyles. The patient was the subject of tertiary syphilis, and the operation was performed three years after an injury to the elbow. The joint is stated to have been completely disorganised. Nine months later she was able to follow her occupation as charwoman with full use of the joint.

† Pronation and supination in a child are often only apparent, the forearm and arm being rotated together from the shoulder.

be allowed, resort to a gymnasium will be very beneficial.* Finally, it is always to be remembered that a twelvemonth must elapse before the full benefits of the operation—viz., a complete combination of mobility and stability—are gained.

TEST OF SUCCESS.—In about four months from the operation the patient should be able to move the new joint freely and efficiently, to dress and feed himself easily, and to lift fairly heavy weights. But it will be nine months or a year before the joint is thoroughly firm and strong.

REPEATED EXCISION.—I have tried this in three cases, two of them instances of obstinate pulpy disease; in each a very useful but much shortened limb resulted. In the third, partial excision had been performed at a provincial hospital for an injury to the lower epiphysis of the humerus in a boy of 14. Great pains had been taken, but the limb was almost completely stiff and at an obtuse angle. After re-excising the joint completely, I secured a useful angle, admitting of the hand being brought to the mouth, placed behind the back, &c., so that the boy could feed and dress himself. The movements of the joint itself remained extremely restricted owing to the absolute apathy and indifference of the patient. While opening up the old wound and again separating the bone ends gives excellent access to the remaining disease, this step will be but seldom required if the rule is followed, after excision of such joints, to give ether repeatedly as soon as there is evidence of persistent disease, and slit up any sinuses or undermined tissues, thoroughly use sharp spoons, and, if needful, pack in, for a few hours, strips of iodoform gauze wrung out of an emulsion of glycerine and iodoform or sulphur. (See the remarks made on this subject under "Excision of the Knee.") Where the tubercular mischief has burrowed out amongst the muscles, where osteitis and osteo-myelitis are also present, amputation is to be preferred, especially if the general condition of the patient is not satisfactory. In flail-like union, where the limb remains quite useless in spite of the employment of a leather support † (which it very rarely does), where the muscles are not helplessly wasted, and no neuralgia is present, re-excision should be tried in preference to amputation, and a trial may be made of uniting the bones with wire.

Other Methods.—I have described excision by a single posterior incision, because I consider that this method gives the best results in the largest number of cases, and is best suited to the majority of operators who will not perform this operation very frequently, and who should, therefore, strive to perfect themselves in one method. The above method is very simple; it affords ample exposure of the joint; its limited interference with the triceps does not prevent the regain of complete extension. Therefore other methods will be very briefly given.

M. Ollier (*loc. supra cit.*, p. 200), while admitting that the single posterior incision allows of the fulfilment of the essential conditions of the subperiosteal method, considers it inferior to his method because it affords less facility for the different steps of the operation, gives less room, and is, besides, inferior as regards the after-treatment. A final and especial objection given is that this incision cannot serve as an exploratory one when the surgeon is uncertain whether he will perform a complete or partial resection. I cannot, with all due respect to Prof. Ollier, accept any of the first three objections as valid ones; and, with regard to partial resections, I have elsewhere (p. 94) stated that my opinion of them is a very unfavourable one.

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* In some cases the regain of only a limited amount of movement is unavoidable—*e.g.*, where an injury to the elbow-joint requiring excision co-exists with a fracture of the humerus necessitating absolute rest of the limb. Here the bone ends must be removed very freely.

† See the case mentioned below (footnote, p. 96).

Ollier's Method by a Bayonet-shaped Incision.—This method, though generally preferred by the above well-known Lyons surgeon, was introduced by him especially for cases in which ankylosis, which could not be broken down, was present in an extended position. An incision is first made above, over the external supra-condyloid ridge, sinking between the triceps and supinator longus about 2 inches above the level of the joint and passing vertically down to the external condyle; the incision then passes obliquely across the olecranon, and below descends upon the posterior border of the ulna for 2 inches. Through this, the main incision, the external condyle, head of radius, and olecranon are dealt with. To expose the inner condyle, make sure of the ulnar nerve, and to detach the soft parts and lateral ligament, a second small incision, about 1½ inch long, is made internal to the ulnar nerve and parallel with the inner border of the humerus. The following appear to me to be objections to the above method. In the first place, ankylosis in the extended position is a rare condition, and the union in this or any ankylosed portion of the joint which cannot be safely* broken down under an anæsthetic can be divided, after the back of the joint has been thoroughly exposed by a single vertical incision, by an osteotome or narrow-bladed saw, and the operation completed in the usual way. I have not found that this step "exposes the neighbouring parts to great risk of injury" (Mac Cormac). Further, the central or oblique part of the incision must surely divide the very important outer expansion of the triceps. Finally, while the main incision exposes fully the parts about the external condyle, the small internal one, while introducing a complication, would be inadequate, with most operators, for the separation of parts on the inner side of the wound.

Method by Two Lateral Incisions.—Both Ollier and Hueter have employed this method largely, especially advocating it in cases of ankylosis. By a small ulnar incision, made vertically, about an inch long, slightly to the front of the internal condyle, the attachment of the flexor muscles and the internal lateral ligament are detached. By a radial incision, 4 inches long, with its centre over the external condyle, the structures on the outer side are next dealt with. The bone ends may be removed by a narrow saw. It is claimed that this method interferes less with the triceps than that by a single posterior incision, and this is no doubt correct. It is well known, however, that after the latter method complete extension may often be regained. Whether the second chief advantage claimed for this method is correct—viz., that the ulnar nerve does not come into view, and is placed beyond the reach of injury—is, I think, considering the amount that has to be done through a very limited incision, much more doubtful. If lateral incisions are employed I should prefer two freer ones, of 3½ or 4 inches long, and to recognise and draw aside the ulnar nerve. Such incisions have been employed by Dr. Stimson, of New York, in the treatment of old unreduced dislocations (*Trans. Amer. Surg. Assoc.*, vol. ix. p. 462).

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* In young subjects, where the ankylosis has lasted long and the bones are atrophied, undue force may break one or more of the bones or injure one or more of the epiphyses above or below the line of ankylosis, instead of loosening this.

Excision in Cases of Gunshot Wounds.—The following points are brought out by Dr. Otis as the results of this operation in the great Civil War of America (*Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 845 *et seq.*). Compared with excision of the shoulder, the results were less brilliant. The cases are divided into the following groups:—I. *Primary Excisions.*—250 cases, with a death-rate of 21·3 per cent.: 27 of the 250 were ultimately amputated. II. *Intermediate Excisions, i.e.*, during the period of inflammation, three to four weeks.—197 cases, with a death-rate of 35·2 per cent., nearly 14 per cent. greater than that of primary excision: 19 were submitted to amputation later on; 62, or nearly half of the cases, were reported to have complete ankylosis.* III. *Secondary Excisions*, thirty days or more after the injury.—54 cases, with a mortality of 9 per cent.

Period of Election.—Dr. Otis, after remarking that this has hitherto been unsettled, states: "I believe that the evidence, when fully analysed, will demonstrate that this resection conforms to the general rule in shot-fractures of the limbs, that primary operations are preferable whenever it is certain that recourse must eventually be had to operative interference." In the future, "intermediate" excision with strict antiseptic precautions and efficient drainage will, probably, be no more dangerous than "primary." The frequency of a flail-joint after "primary" excisions is due (α) to the large amount of bone often removed, (β) to the small reparative power of the periosteum uninflamed at this stage, (γ) to the often necessarily inefficient after-treatment. Sir W. Mac Cormac writes (*Surg. Oper.*, pt. ii. p. 380): "In military surgery most authorities agree that the danger to life is less after a primary resection, but the functional results are not so good, and primary resection is, as a rule, impracticable in the field." In some of the above cases removal of detached fragments seems all that was done. This incomplete operation does not appear to be more successful in military than in civil surgery. As pointed out by Prof. Esmarch, free division of the capsule of the joint deprives the wound of much of its danger.

With regard to the results of this operation in the Franco-German war, Dr. Otis (p. 904) says that the average results met with by the Prussian surgeons are not discouraging, but the results reported by the surgeons attached to the French army of that day are "simply appalling." Dominick has tabulated 263 cases in which the results were accurately noted after the Franco-German war: in 28 cases (10·6 per cent.) there was good active motion, and a more or less useful hand; in 129 cases (49 per cent.) ankylosis took place, in 31 with a useless hand; in 24 cases there was an "active" flail, with a more or less useful hand; in 41 cases a "passive" flail-joint, with a useless extremity.

PARTIAL EXCISION.—The value of this has been disputed. I have already (p. 82) expressed myself as unfavourable to it. I have had opportunities of watching three cases which came under my observation with removal of the condyles in the one and the olecranon process in the two others. A most unsatisfactory amount of stiffness persisted. In cases of disease I should never recommend it, as it is likely to be followed by imperfect removal of the parts affected as well as by ankylosis.[*] So, too, this step should be rejected in cases of ankylosis.[†] In excision for injury it would be permissible to leave the articular ends of the bones of the forearm untouched when it had been needful to remove the end of the humerus very freely. In such cases careful passive and active movements would be additionally called for. The only cases in which partial excision of the elbow-joint would recommend itself to me are such instances as the case of excision of the head of the radius and lower end of the humerus related at p. 98, and the more common one, excision of the fractured internal epicondyle or epitrochlea. Removal of this process will be especially indicated when it is made out, at once or later on, to be the cause of limited movement in the elbow-joint, or when it is the cause of pressure upon the ulnar

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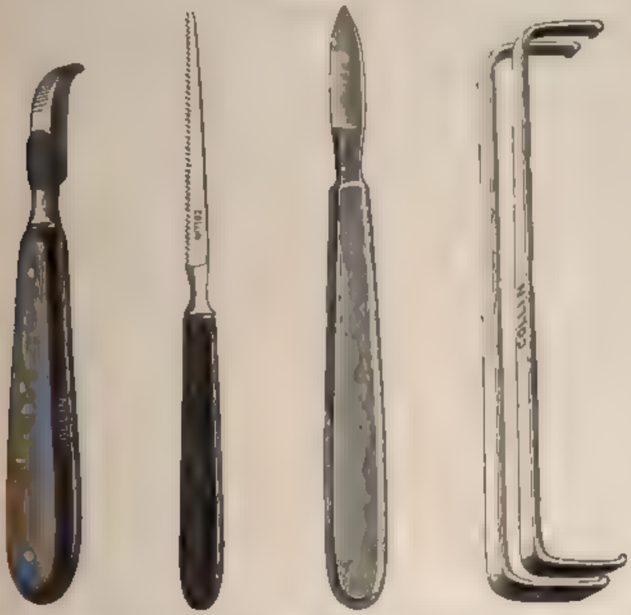
* Thus, if patients escape the risks of operations on inflamed soft parts, bones, &c. (p. 81), the ultimate result may be a fixed joint.

Fig. 52.



Periosteal elevator and other instruments of very useful pattern for excision of joints. (Farabeuf.)[‡]

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[*] In support of the above opinion I would refer my readers to the following case, under the care, be it noted, of a surgeon with scarcely rivalled operative experience—Billroth (*Clin. Surg.*, p. 370). "In a well-nourished child, æt. 14, who had had disease of the elbow for six years, originating without known cause, I partially excised the joint, *i.e.*, removed only the carious portions of the trochlea and the olecranon, together with a small part of the condyle of the humerus. The parts healed up, but complete ankylosis followed. This was forcibly broken down under anæsthetics, but considerable reaction invariably followed, and the ankylosis returned as before. I then resected the joint again, removing the end of the humerus subperiosteally, with a satisfactory result."

[†] Sir W. Mac Cormac points out that in these cases to excise the end of the humerus alone will not permit of pronation or supination afterwards, as the radius and ulna are soldered together at their upper end.

[‡] They can be obtained at Hawksley's, 357 Oxford Street; also from Down Bros.

nerve.* Cases in which the epicondyle has been successfully removed for the latter reason will be found recorded by Mr. J. Hutchinson, jun. (*Brit. Med. Journ.*, vol. i. 1892, p. 113), and Mr. Poland (*Traumatic Separation of the Epiphyses*, p. 355), this latter surgeon giving several cases besides his own. I may remind my readers that in some of these cases of fractured internal epicondyle the joint is opened and serious ankylosis will follow expectant treatment. Further, that in many of the recorded cases of separation of the internal epicondyle, the joint having apparently escaped, the amount of ankylosis which follows is quite out of proportion to the slight amount of injury (Malgaigne, quoted by Poland, *loc. supra cit.*, p. 376). In such cases more than a partial excision will be required. Dr. G. E. Davis, of Philadelphia, has recommended partial excision, viz., removal of the internal condyle, with a view of correcting a deformity after injuries to the lower end of the humerus in young subjects, viz., cubitus varus. Three cases are given with successful results (*Annals of Surgery*, Jan. 1899).

Unfavourable Results of Elbow Excision.

1. Persistence of pulpy disease. This is especially likely when, previous to the operation, the capsule has been perforated and pulpy disease has burrowed out amongst the origins of the flexors or extensors. 2. Caries and chronic osteo-myelitis. These are not unlikely to supervene when the reparative power is poor and the wound becomes septic. 3. Ankylosis. This is not uncommon in children, owing to the great tendency of inflammatory products to organise quickly in early life. Furthermore, there is the difficulty of getting them to use the joint or submit to passive movement; all they will do is to move their arm and forearm from the shoulder-joint (p. 91). 4. A flail-like joint.† A limb may remain weak for some time, owing to the muscles not taking on firm attachments. Friction and galvanism should be used perseveringly. If there is too much separation between the ends, the patient should wear a well-moulded support; the use of the hand and fingers will thus be retained, and, if the patient is young, gradual and great improvement will very likely take place in the elbow. Re-excision and wiring may be tried in some cases with healthy patients. According to Sir W. Mac Cormac (*loc. supra cit.*, p. 398) most of the flail-joints follow the extensive removal of the lower end of the humerus, especially in cases of injury. In such cases the periosteum of the condyles and the muscular attachments should be as little interfered with as possible. He points out that flail-joints are of two kinds:—(1) Active flail-joints, in which the muscles are strong and exercise control. These may be very useful, especially when aided by a support to the elbow. (2) Passive flail-joints, where the muscles are wasted, and the hand only can be used by the employment of a supporting splint. 5. If the wound becomes septic, cellulitis, erysipelas, &c.

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* The nerve was in a groove at the back of the process, being held in place also by fibres which pass from the epicondyle to the olecranon, giving attachment to part of the flexor carpi ulnaris.

† Mr. C. Forster (*Lancet*, 1872, vol. i. p. 3) related a case in which the right limb was a perfect flail, yet with the help of a leather moulded splint all the movements of the fingers were good, and the patient could do needlework and write well. Such a splint is capped to the shoulder and moulded to the limb down to the wrist, leaving the fingers free, and strapped round the chest.

6. Secondary hæmorrhage. This occurred in 11 out of 250 military cases (Otis, *loc. cit.*, p. 860). 7. A useless limb, owing to the muscles being utterly wasted from long disease and disuse. 8. Injury to the ulnar nerve, with its resulting interference with motion, sensation, and nutrition. 9. An adherent scar.

ERASION OF THE ELBOW-JOINT.

This operation has not been extensively practised, partly on account of the good results given by a carefully performed excision, and partly because this joint does not lend itself to free exposure by so simple an incision as in the case of the knee-joint. The statement of some surgeons that in children, at the present day, excision of joints for tuberculous disease is quite unnecessary, as erasion is perfectly satisfactory, requires qualification. Whatever be the joint, excision can only be perfectly satisfactory if performed in suitable, *i.e.*, early, cases. Where the bones themselves are not diseased, erasion will give better results than excision; but tubercular disease of the joints, and among them the elbow, does not always come before the surgeon in its early stage.

Mr. Clutton, at a meeting of the Medico-Chirurgical Society (*Brit. Med. Journ.*, Dec. 16, 1893), advocated early erasion of the elbow-joint in place of late excision. He exposed the joint by dividing the olecranon. Nine cases were thus treated. Of these the first two had ankylosed joints, but very serviceable limbs. Six cases resulted in more or less movement in the joint with cessation of the disease. The ninth and last case was subsequently excised.

While I would, first, allow that I have no personal experience of erasion of the elbow-joint, I am very doubtful if this operation will give results equal to those of a well-performed excision. That in experienced hands erasion will usually remove all the disease, is clear, but here we want a movable, and a freely movable, joint as well. Judging from Mr. Clutton's cases, I doubt if the latter will be obtained if erasion of this joint comes into vogue on a large scale. And, speaking from an experience of some forty cases of erasion of the knee, I think, after erasion, there must be a tendency to fibrous ankylosis between the ends of the bones which are left. Now, this is not a matter of much importance in the lower extremity, where a firm support, as little shortened as possible, is the chief point to be attained. In the case of the elbow-joint, on the other hand, complete removal of the disease and free mobility are the height of our desires. The latter certainly—and, I believe, the former also with the majority of operators—will be best attained by excision with free removal of the ends of the bones (p. 88). Next to thorough exposure and complete removal of the disease, a freely movable joint is what we require here, and, if this be attained, it matters but little if the limb is shortened.

EXCISION OF THE SUPERIOR RADIO-ULNAR JOINT.

Indications.—This operation may be, very occasionally, made use of, with antiseptic precautions, in old cases of dislocation of the head of the radius, where reduction has not been effected owing to the amount of swelling, &c., and where the movements of the forearm are much hampered, especially in a young and healthy adult.

Operation.—An incision about 2 inches long is made over the projecting head of the bone behind or through the posterior part of the supinator longus. The soft parts having been separated with a blunt dissector and held aside with retractors, the neck of the radius is carefully divided with a fine saw or cutting bone-forceps. Sufficient bone must be removed here or from the external condyle to leave a gap that will avoid the risk of fresh ankylosis. The musculo-spiral nerve lies to the inner side, and great care must be taken not to interfere with this or the biceps tendon. The forearm should be put through its movements (p. 89) freely but carefully, while the patient is under the anæsthetic, so as to break down adhesions. Any needful drainage should be provided, and every care taken, by not interfering with the soft parts more than is absolutely needful, and by keeping the wound aseptic, to secure primary union, and thus avoid the risk of stiffness again occurring. After a few days a sling may be substituted for a splint, and, ten to fourteen days later (p. 91), passive movements made use of daily, with the aid of an anæsthetic if needful.

In October 1894 I excised the head of the radius in the following obscure and instructive case:

In the previous August the lad, aged 12, had fallen from a ladder partly on to his feet, partly on his right elbow, not on the hand. Much swelling of the joint had followed, with subsequent stiffness, rendering the limb very useless. Passive movement had been tried, but the patient had done his best to render the result negative. The forearm was fixed in a position midway between pronation and supination, and flexed at a right angle. No flexion possible beyond this. Passive extension to about 120°. Pronation and supination, passive and active, quite abolished. A prominence—? the head of the radius—to be felt below the external condyle, but not admitting of rotation; there was no crepitus. Dr. Harsant, of Bristol, sent me the case as one probably of dislocation of the head of the radius, and with this view I agreed, though against it were the history of direct violence and the absence of any rotation in the swelling. On exploration of the injury by a free lateral incision, it turned out to be one of those rare cases of fracture through the neck of the radius. Just below the external condyle the head of the radius was found separated from the shaft by a fracture through the upper part of the neck, and lying with its articular surface turned directly outwards. On removal of this there was distinct improvement in pronation, but little in supination. Flexion was now possible to 40°, and extension to almost the complete range, but only on forcible movement. As the movements were still incomplete, and certainly would not be retained, I removed the capitellum of the humerus from the same incision with a narrow osteotome. The forearm could now be put through its full range of movements. The wound healed under an aseptic clot, and the patient, when he left my care five weeks later, had recovered almost complete active movements of the joint, though the whole limb was still weak. Three months later I heard that he could "do everything nearly as before the accident, and that he could also carry considerable weights."

Mr. Wainwright (*Clin. Soc. Trans.* vol. xix. p. 332) records a somewhat analogous case, in which, in an adult, he removed the head of the radius, which was vertically fractured, and the coronoid process, which had been imperfectly united with fibrous tissue. The accident had taken place three months before. The movements of the limb were distinctly improved by the operation.

UNUNITED FRACTURE OF THE OLECRANON.

Indications.—For fuller details the reader is referred to the remarks on treatment of ununited patella by wiring. A. *Simple Fracture.*—(1) Where, in spite of careful treatment, the limb is weak and its usefulness seriously interfered with, especially where the occupation of the patient requires vigorous extension of the elbow.* (2) Where such treatment has not been used, but the time for it has gone by. In either case the patient should be young and healthy. His future life and the surroundings under which this will be spent must also be taken into account. The object of the operation and its possible risks should be fully explained to him. Moreover the patient should realise that a union, however close and useful it may be at first after a judicious employment of splints, will not remain so if submitted to constant and laborious work. Another clear but rare indication for wiring is when both olecrana have been fractured, or when a patient, in addition to a fracture of one olecranon, has a fracture anywhere in the opposite upper extremity, thus rendering him very helpless. So far, I have spoken of this operation as a secondary or later step. It will be quite justified directly after the injury, under favourable surroundings, in a healthy patient to whom the unimpaired movements of the limb are of the first importance. And the indication for operation here will be greater if there be much lateral tearing of the joint capsule, as shown by distension and bulging. B. *Compound Fracture.*—Here the operation is distinctly indicated in skilful hands. The free incision required will relieve the tension of the ecchymosed soft parts, it will aid the needed antisepsis, it will admit of the removal of any detached fragments, it will enable the surgeon to empty the joint of clot, which, even if it do not suppurate, will persist tediously and impair future movements. Finally, it is taken for granted that a surgeon undertaking this operation has good reason for feeling confident in his knowledge of antiseptic surgery.

Operation.—The parts having been rendered evascular by properly applied Esmarch's bandages, and the region of the elbow-joint again duly cleansed,† a longitudinal incision is made for 3 inches over the back of the joint, opening this and exposing the fragments. Any adhesions —*e.g.*, between the upper fragment and the humerus—are then removed or broken down. Retractors having been placed in the wound, any fibrous tissue is separated from the contiguous edges of the fragments, and a thin layer of bone removed from each, either with a chisel or a narrow, sharp saw. I prefer the latter. Mr. Treves, who uses a chisel, steadies the fragments by lion-forceps, the blades of which are without teeth. A hole is then drilled obliquely through each fragment with a bradawl or drill, and sufficiently stout‡ silver wire passed§ and twisted up. The use of a single wire placed centrally is quite sufficient, though two ensure more accurate apposition of the fragments. One half-twist or a complete one is made according as the surgeon intends to remove or leave the wire. If the surgeon decides to leave the wire in, he now cuts the ends short and hammers them down into grooves carefully made in the periosteum of the olecranon. If he is going to remove them later on, he leaves the ends, not cut too short, projecting through the wound, which is next closed with sutures of sterilised salmon-gut, any lateral tears in the capsule having been first united with buried chromic gut. A dry wound is essential. The periosteum and fibrous tissues should be drawn together over the wire. Any other injury—*e.g.*, to the ulnar nerve—should be attended to.

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* The surgeon will examine how far this power is lost, to what extent the triceps has wasted, and what evidence of union there is between the fragments.

† The area of the wound is widely shaved, and then thoroughly soaped and scrubbed. The skin is next disinfected (1) by turpentine, (2) by soaking it for a few minutes with a solution of biniodide of mercury and methylated spirit (1 in 500): (3) this is washed away with a watery solution of biniodide of mercury (1 in 2000); (4) an antiseptic dressing—*e.g.*, iodoform gauze soaked in and well wrung out of the above watery solution of the biniodide, and over this salicylic wool—is well bandaged on till the operation.

‡ Lord Lister (*Lancet*, 1883, vol. ii. p. 761) gives wire about $\frac{1}{25}$ inch as amply sufficient for the olecranon, while for the shaft of the femur, in an adult male, a piece of wire about $\frac{1}{10}$ inch in thickness is requisite in order to resist with certainty the enormous force of the great muscles of the thigh.

§ For difficulties in this, and how to meet them, see "Wiring of the Patella."

Two questions arise here. One, Should the wire be left or no? I have alluded to this question more fully later on, in the treatment of fractured patella by wiring. The chief objection there given—viz., the inability to bear pressure on the wire, as in kneeling—is wanting here. Two others have been raised: the possibility of ulceration setting in about the wire and causing trouble, and the risk of the patient's attention being constantly attracted to the pricking of the wire. Neither of these are likely to occur in a manly, sensible patient if the wound run an aseptic course, if wire of a suitable size be used, and if it be properly hammered down.* If the wire be left, the patient will probably be able to return to work after a much shorter interval, viz., three to four weeks. The risk is slight if he report himself at intervals for a few months. When a patient is nervous and anxious, or when his occupation entails much leaning on the elbow, the wire should be removed four to six weeks after the operation. Occasionally here, as in the case of the patella, removal of the wire is a matter of some difficulty. In withdrawing it, after making certain that it is untwisted, the surgeon should make his traction downwards towards the ulna, not upwards towards the humerus.

The other question is about the drainage. In a case of secondary suture, if the parts have not been much interfered with, if but little separation of adhesions has been necessary, probably no drainage will be needful if the wound has been kept aseptic throughout. But where contrary conditions are present, or in a case of primary suture where there is much ecchymosis superficial and deep, where there is any risk of sloughing and sepsis, drainage should be employed, and but few superficial sutures. Some such splints as those mentioned on p. 90 should always be employed at first, owing to possible restlessness after the administration of the anæsthetic and movements during sleep.

Movement should be begun about the third week, and continued with the persevering and intelligent co-operation of the patient. Without this, ankylosis is very likely to follow.

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* This is essential. In August 1897 I wired the right olecranon of a young baker, using two wires. He returned to full work, and in December 1897 there was a little redness over the site of one wire. I removed this, and the other wire has given no trouble for the twelve months that have followed. No doubt I had insufficiently housed the suture which threatened to give trouble. In a case of Lord Lister's (*loc. supra cit.*) the wire was not completely removed from the olecranon, for, the loop having given way near the twist, the twisted part was alone taken away, and the loop left behind, but without causing any inconvenience when the patient was last heard of.

VENÆSECTION.

Indications.

1. Some cases of pneumonia after injury, as where a plethoric young farmer breaks several ribs when riding, and acute pneumonia sets in and extends rapidly.—Here the cyanosis, orthopnœa, the distressing pain, may all be relieved by a bleeding of eight to ten ounces, which very likely will have to be repeated.

In other cases of acute pneumonia which are not traumatic, bleeding may occasionally be resorted to with great advantage when the patient is young and of full habit, the breathing much oppressed, and the heart's action becoming embarrassed. Owing to the tendency to cardiac failure in this disease the decision here is a very critical and difficult one.

On this point I will quote from a very instructive paper by Dr. S. West (*Brit. Med. Journ.*, 1892, vol. ii. p. 992): "I wish to make a few remarks in reference to pneumonia. In the first place, it is generally agreed that no patient with pneumonia should be bled if it can be avoided; but, at the same time, conditions may arise in which bleeding may be really the only means of saving life, the conditions being those already referred to, namely, rapidly increasing cyanosis and failure from over-distension of the right heart. Still, such cases are, at the most, rare. Bleeding in pneumonia, if unnecessary, must be harmful, for cardiac asthenia is one of the chief dangers, and the risk of it is increased by bleeding. A vicious circle is thus established, for cardiac failure may itself produce the very symptoms regarded as indications for the bleeding, which in its turn will increase the cardiac weakness which has caused the symptoms. The question must be decided largely by the condition of the left ventricle, and it is unnecessary to say how difficult this is to determine. When the left ventricle is weak and failing, bleeding can do no good; when it is strong, bleeding may save life. Thus in pneumonia bleeding becomes a critical measure. It may save life, but it may, if wrongly employed, take all chance of life away."*

2. In some cases of chronic bronchitis.—The late Dr. Hare† drew this graphic picture of such a case:

> A middle-aged man with chronic bronchitis and some congestion of the lungs has exposed himself to chill. He is sitting in a chair (to lie down is impossible for him), his face is blue and sunken, his lips purple, the eyes suffused and staring . . . . his chest heaving, and each short gasping inspiration followed by a long wheezing and moaning expiration; his lungs are full of [illegible] sonorous and mucous rhonchi, scarcely a trace of vesicular murmur is to be heard, and he is pulseless. He looks to you beseechingly, and gasps out in scarcely articulate words that he is dying. This is not true. Now, the treatment for such a condition at the present day is to pour in stimulants (though the patient can scarcely swallow). Brandy and water are given, and ammonia and perhaps ether; then, if the patient lives long enough, mustard poultices are applied to the chest and the calves and feet, and the patient is failing and the [illegible] . . . . Appearances have been saved, but not the patient's life. The [illegible]

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* Dr. Lucas [illegible] brought the advantages of [illegible] before the Medical Society (*Brit. Med. Journ.*, [illegible] 1892 [illegible]

† *Brit. Med. Journ.*, [illegible] Very interesting papers [illegible] will be found by Dr. [illegible] *Med. [illegible] Journ.*, vol. lxxx[illegible] p. [illegible], Dr. [illegible] and Dr. Wilks (*Lancet*, [illegible]

danger lay in the right side of the heart being gorged with blood, so that it was impossible for its stretched and distended walls to contract and to propel forwards the thick and blackened blood. . . . . Open one of these veins, which are, with every systole of the heart, tending to carry more and more blood to this already distended right ventricle, and all may yet be well with your patient."

3. Where a tendency to apoplectic seizures exists.[*]—Dr. Hare (*loc. supra cit.*) thus wrote of this class of case. Nature speaks "in unmistakable language when by a copious epistaxis she efficiently relieves the congested turgid face,[†] the beating temples, the dull heavy headache, the sleepiness, the confusion of thought, and other symptoms, which in a plethoric individual betoken, if they are not relieved, serious danger, if not an apoplectic attack."

4. In aneurisms, especially thoracic.—As part of the treatment of Valsalva in a modified form. Formerly the bleedings in aneurysm were copious even to syncope. Nowadays they are made use of differently. They are small in amount, and are only repeated so far as to reduce excessive action of the heart, or to relieve certain symptoms (as they undoubtedly do), viz., dyspnœa and pain.

Dr. MacDougall, of Carlisle, in a most interesting paper (*Amer. Journ. Med. Sci.*, 1887, p. 38) points out the following as cases in which venæsection should be more often used when other means have failed. (1) Details are given of a case of mitral and aortic incompetence, with chronic Bright's disease and acute pleuro-pneumonia, in which recovery followed epistaxis to the amount of a pint. (2) Reaction after concussion, with a full, slow, labouring pulse, and headache. (3) In epilepsy in strong, big, healthy patients, venæsection will relieve the cerebral stasis. (4) In some cases of "croup," in late childhood, or in vigorous adolescents. (5) In acute pleurisy, with intolerable pain, unrelieved by morphia; where there is not much effusion, but lymph formation over a wide surface. (6) Very rarely in acute pneumonia, bilateral, in young healthy subjects, with a small pulse and strongly beating heart (*vide supra*). It is pointed out that the pyrexia here favours the dilatation of the right side of the heart. (7) In suffocative pulmonary catarrh with a trace of albumen and a few granular casts.[‡] (8) In some cases of convulsions, *e.g.*, (*a*) after scarlatinal nephritis; (*b*) in parturient or pregnant women[§]—*i.e.*, in severe attacks, with extreme congestion, profound coma, and hard pulse; (*c*) in plethoric coma, preceded by headache, in full-blooded women about the time of the menopause.

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[*] This does not mean those cases where a rupture of a cerebral vessel has occurred, and where bleeding would interfere with that process of repair on which the patient's life depends.

[†] Dr. Copeman (*Brit. Med. Journ.*, 1879, vol. ii. p. 932) points out that in these cases, in addition to plethora and a full habit, evident distension of the superficial veins of the head and neck is a valuable indication that bleeding is proper.

[‡] Dr. West (*loc. supra cit.*) gives two cases of sudden dyspnœa and cyanosis, associated in the one case with mitral disease and pulmonary infarcts, in the other with double aortic disease, in which venæsection to eight ounces and a pint respectively prolonged life, in the one case two days, and in the other three months, in comparative comfort.

[§] Dr. Thomas, in advocating before the Border Counties Branch of the British Medical Association the use of venæsection in those cases of puerperal eclampsia where fits

To the above indications Dr. West (*loc. supra cit.*) adds the following:

> In two cases the bleeding was performed early for cerebral symptoms of great gravity. One man, æt. 54, who had been seen to fall while walking, had fits affecting the left side of the body, hand and forearm, then leg, neck and, lastly, the face. The pulse was 108, of high tension. There was no evidence of injury from the fall save a few scratches on the face. The lesion was diagnosed as a hæmorrhage either into the cortex or the pia mater, and the patient was thought to be dying. After the withdrawal of 30 ounces of blood the pulse fell, and the fits diminished in frequency, then ceased, and did not recur. Some paralysis of the limbs followed, but by the tenth day all power seemed to have been regained.
>
> The second cerebral case was that of a man, æt. 42, who was suddenly seized with convulsions of the right side of the face and aphasia, the convulsions soon involving the whole of the right side, then becoming general, but being much more marked on the right than on the left side. As they became increasingly violent, with stertor, cyanosis, and complete unconsciousness, and as the patient was of a plethoric condition and his pulse of high tension, 40 ounces of blood were taken from the right arm. Ten minutes later, as the fits were recommencing, he was bled again to 25 ounces and faintness. The fits did not cease entirely until sixteen hours after their commencement, but they were shorter and less severe. The patient left the hospital well, but with diminished power of the right hand.

Operation.—The skin having been cleansed (p. 99), the patient being usually in a sitting position, and a bandage tied round the middle of the arm with sufficient tightness to retard the venous circulation without arresting that in the arteries,[*] the surgeon selects the median cephalic or the median basilic, whichever is more prominent.[†] Steadying this vein by placing his left thumb upon it just below the point of intended puncture, and with his right hand resting steadily upon its ulnar margin, he opens the vein with a small, sharp scalpel, scrupulously clean, making with a gentle sweep of his wrist a small incision, and not a mere puncture, into the vein. The anterior wall of this being divided, the point, without penetrating any deeper, is thrust onwards, first increasing the slit in the vein, and then being brought out vertically, care being taken to make the skin wound larger than that in the vein. The thumb is now raised and the stream directed into the measuring-vessel.[‡] While the blood is escaping, the limb should be kept in the same position, lest, by the skin slipping over the wound in the vein, the blood should be prevented from escaping freely and thus make its way into the cellular tissue.

The required amount of blood having been withdrawn, the thumb is placed on the wound while the bandage is removed. A small pad of aseptic gauze is then placed on the puncture, and secured with a bandage applied in the figure of 8. This pad may be removed in about forty-eight hours, and for a day or two the patient should use a sling.

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occurred previous to labour and where the administration of chloroform and immediate delivery by turning were impossible, evoked an instructive discussion from a body of men well qualified to give an opinion (*Brit. Med. Journ.*, vol. i. 1898, p. 400).

[*] The surgeon makes use of the pulsation in the arteries to tell the relation of the brachial, or one of its branches given off abnormally high up and running superficially, to the veins at the bend of the elbow (p. 115).

[†] If the patient is nervous, or if the veins are small, he should be told to hold a walking-stick or book. This steadies his arm, distracts his thoughts, and, by producing muscular contraction, supports and fills the veins.

[‡] Not a drop of blood should be allowed to go on to the bed or the patient's linen.

Difficulties during, and Complications after, Venæsection. (1) Difficulty in finding a vein.—This may be due to their small size, the feebleness of the circulation, or the abundance of fat. If a vein cannot be made sufficiently distinct by hanging down the limb, putting it in warm water, flexing and extending the wrist and fingers, and chafing the limb, one should be opened on the back of the hand, or blood withdrawn from the external jugular or internal saphena at the ankle. (2) In other cases, where the patient is much emaciated, owing to the absence of steadying fat the mobility of a vein may enable it to avoid puncture, unless a very sharp instrument be used and the vein well steadied. (3) When the vein has been opened, sufficient blood may not escape owing to—(*a*) The opening may be a mere puncture. (*b*) The skin opening may be insufficient in size, or not parallel in position to that in the vein.—These impediments are removed by a freer use of the knife, carefully made, or by bringing the wound in the vein parallel with that in the skin. (*c*) A pellet of fat may block the opening in the vein.—This should be snipped away. (*d*) The patient may faint. (*e*) A thrombus may form. This will disappear when the venous current becomes more active. (*f*) The bandage may be tied too tightly round the arm. (4) Wound of the brachial or some other artery, *e.g.*, an abnormal ulnar.—This can always be avoided by a careful use of the scalpel, and by noting beforehand the existence of any pulsation. The force of the jet and the mixture of bright with dark blood will tell of this accident. Pressure should be carefully applied and maintained (p. 27), and blood taken from the opposite arm if required. (5) Escape of blood into the cellular tissue.—This will lead to ecchymosis, and perhaps formation of a thrombus, which may be absorbed, but which also may suppurate. (6) Phlebitis, or inflammation of the lymphatics.—These may be due to the use of dirty instruments, aided by a low condition of the patient. They should be most carefully guarded against, as likely to lead to the following two most grave results: (7) Erysipelas and cellulitis. (8) Intense pain in the limb, with gradual flexion of the elbow-joint.—This is due to puncture of the external or internal cutaneous nerves, which are connected through the brachial plexus with the motor nerves to the brachialis anticus and biceps, which flex the elbow-joint.* The injured nerve should be divided, subcutaneously if possible; or the scar excised.

INJECTION OF SALINE FLUID. TRANSFUSION.

These operations, especially the first, have of late years been so much simplified that every practitioner should be ready to inject saline fluid, owing to the critical nature of the cases which call for it, the suddenness with which the call is liable to come, and the excellent results which often follow.

INJECTION OF SALINE FLUID.

While this method had been occasionally made use of by several different workers for many years—*e.g.*, the Littles in the cholera epidemics at the London Hospital in 1848 and 1866, and many others, sporadically, at most of our hospitals,—it was Dr. William Hunter who, in 1880, by his Arris and Gale Lectures (*vide infra*), again drew the attention of the profession* in this country to the great importance of injection of saline infusion in sustaining life, if only sufficient fluid was added to keep it in circulation. Further, it was Mr. W. Arbuthnot Lane who, applying the above experiments to Surgery in two brilliantly successful cases,† again drew the attention of the profession to the value of this method more forcibly than had been done before.

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* Hilton, *Rest and Pain*, p. 190.

In his three lectures on Transfusion which Dr. William Hunter gave before the College of Surgeons (*Brit. Med. Journ.*, vol. ii. 1889, pp. 117, 237, 305), the advantages of transfusion and injection of saline fluid are contrasted, and the following most important conclusion arrived at (p. 309):—"For practical purposes all the advantages to be gained by transfusion may, I believe, be equally well and more readily obtained by infusion of a neutral saline, such as ¾ per cent. solution of common salt (about 1 drachm to the pint)." It is clearly shown in these lectures that, with regard to transfusion, the nutritive value of *serum* is so small that its chief value here must depend upon its physical properties, and these are in no respect greater than those of a corresponding quantity of neutral saline solution. With regard to the *red corpuscles* the same authority writes (*loc. supra cit.*, p. 305): "The greater the quantity of blood transfused, the longer are red corpuscles likely to remain within the circulation, and the more likely is their hæmoglobin and the iron which it contains to remain within the system. Over this factor, however, we can execute but little control. The quantity of blood transfusible in man can rarely be more than about 5 per cent. of the blood already in the body. And the life duration of the red corpuscles under such circumstances is probably to be reckoned by a period of hours." Again, a little later (p. 308), we are told on this subject that, "it may be stated that there is scarcely a single condition of the blood in which the want of red corpuscles is a source of urgent danger. After the greatest loss of blood in animals, a sufficient number of red corpuscles always remains in the circulation to carry on respiration, provided that the circulation is maintained. . . . . In man the loss of blood can never be so great as in animals. Syncope occurs earlier. Transfusion of blood is, therefore, never required for the purpose of supplying red corpuscles to carry on respiration after sudden loss of blood in a patient previously healthy. The immediate source of danger in such cases is not the want of red corpuscles, but the disturbance of the relation between the vascular system and its contents. . . . . The immediate source of danger from sudden loss of blood is the fall in the blood-pressure to a point where the circulation is unable to be maintained. The obvious indication, therefore, is to raise the pressure within the vessels." Dr. Hunter then points out that, *bulk for bulk*, pure or defibrinated blood must possess a certain physiological value—*e.g.*, a greater and more immediate effect in restoring the tone of the vasomotor centre than saline solutions. "These advantages, however, are more than neutralised by the greater disadvantages—namely, (1) the difficulty of obtaining blood in sufficient quantity or with sufficient rapidity as compared with the ease with which simple saline solution can be prepared; (2) the danger attending the transfusion if compared with the absolute freedom from danger possessed by salt solution; and (3) the doubtful value of the transfusion, whether hæmogenic or physical, when compared with saline fluid."

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* About the same time the late Dr. Woolridge, in experiments unpublished owing to his untimely death (and alluded to, *Lancet*, vol. i. 1891, p. 626; *Brit. Med. Journ.*, vol. ii. 1892, p. 491), was also proving that, after hæmorrhage sufficient to be fatal, enough hæmoglobin still remained to sustain life, if only sufficient fluid were added to keep it in circulation. Dr. Herbert R. Spencer (*Lancet*, vol. i. 1892, p. 1289) considers that Golz (*Virch. Arch.*, Bd. xxi. and xxix.), and Kronecher and Sander (*Berl. klin. Woch.*, 1879, No. 52), were the first to suggest saline infusion and explain its action. Dr. Spencer claims (*loc. supra cit.*) the first successful case of injection of saline fluid, in a patient the subject of post-partum hæmorrhage, as long ago as April 1888.

† One of these cases is published (*Lancet*, vol. ii. 1891, p. 626). The other was a case admitted for hæmorrhage after partial removal of the tonsil. Here, by ligature of the common carotid and injection of saline fluid, the patient was rescued from the very gravest peril.

The chief **indications** are:

1. Acute traumatic anæmia, such as hæmorrhage after accidents, operations, cut throat, and that connected with childbirth.—Five most carefully reported and instructive cases, under the care of Mr. Pye Smith, of Sheffield, will be found in the *Lancet*, vol. i. 1892, p. 913; of these three were successful. In two Mr. Pye Smith made use of the infusion of saline solution *before* the amputation. Dr. Herbert Spencer's paper, already referred to, gives good instances of the cases in which infusion may be resorted to with benefit in the hæmorrhage of childbirth—*e.g.*, cases of accidental hæmorrhage, placenta prævia, and adherent placenta.

2. Collapse and shock.—Here infusion of saline solution may also be resorted to, but less hopefully, with a view of stimulating the weak action of the heart and combating the loss of vascular tone which accompanies it. The injection of strychnia (gr. $\frac{1}{20}$ of the sulphate) hypodermically is especially indicated here.

The late Dr. Sturges published (*Lancet*, vol. i. 1892, p. 86) a case in which severe collapse from vomiting and diarrhœa in a child of nine months, the subject of congenital syphilis and rickets, was successfully tided over by the infusion of salt solution injected by Mr. Horace Collier. Other treatment having failed, the left external jugular was exposed, and 12 ounces of distilled water containing 36 grains of common salt and rather more than a drachm of brandy were slowly injected. The very marked restlessness which followed was combated with opium. The child recovered.

3. Other, rarer, indications are diabetic coma and septicæmia; in the latter on the ground that it facilitates the removal, especially by the kidneys, of the micro-organisms and their toxins.

4. In the case of certain poisons—*e.g.*, carbolic acid – Dr. Oliver, of Newcastle (Prof. Allbutt's *System of Medicine*, vol. ii.), drew attention to the insufficiency of washing out the stomach when once a poison like carbolic acid has got into the blood, and to the need of infusing with saline fluid, as this is in great part rapidly excreted by the kidneys and carries much of the poison away with it. It is to Dr. Powell, House-Physician at the Royal Infirmary, Newcastle, that the merit

is due of putting the above opinion to a most successful test (*Lancet*, 1898, Nov. 19, p. 1326).

A woman, æt. 21, who had, about three-quarters of an hour before her admission, swallowed seven drachms of ordinary commercial carbolic acid, was brought in, in a state of coma and collapse. While the stomach was being washed out, the left internal saphena was opened in the leg, and eight ounces of blood removed.* Four pints of a saline solution, at a temperature of 110°, were then injected. Half a pint of milk beaten up with two eggs was given by the stomach-tube. The pulse and respiration gradually improved. Glycerine in drachm doses was given frequently to allay the burning sensation in the pharynx and œsophagus. For three days the urine was dark green, but never contained albumen. Recovery was rapid and complete.

Method.—The instruments used should be as simple as possible. A teaspoonful of common salt is dissolved in water which has been recently boiled.† About four pints of such a solution should be at hand, and kept, covered, at a temperature of about 100°. The skin over the vein selected is first sterilised. The vessel chosen is usually the median basilic or the cephalic. Either is exposed by an oblique incision beginning to the inner or outer side of the biceps tendon. Where there is any difficulty in finding a vein here, owing to their collapsed state or to the arrangement not being normal, a skin-flap should be turned up, or gentle pressure made on the basilic or the cephalic a little higher up, and the trunk exposed here. Or the patient's leg may be allowed to hang down, and the internal saphena opened just in front of the malleolus. Two catgut threads are now passed under the vein exposed. The lower being tied round the nozzle of the cannula (one of metal or glass may be used, as long as it is of appropriate size and sterilised), any large convenient syringe is attached to the cannula by means of india-rubber tubing, and the fluid is slowly injected. A word as to the cannula and syringe. The former are sold both sharp-pointed and blunt: the first are said to have the advantage of more readily entering a collapsed vein, but it must be remembered that it is easy to send one of these between the coats of the vein, or even to transfix it. I prefer, therefore, a small cannula with a blunt point. The cannula should, if possible, possess a stopcock, but this is not necessary. The syringe—of glass, if possible, and only used for this purpose, to ensure cleanliness—should be a large one, and the piston fit snugly; but as these essentials in a glass syringe are difficult to secure, and as, even with a large one, the process of injecting four or five pints is somewhat prolonged, and allows of several opportunities of admitting air into the circulation, it is preferable to inject the fluid with a funnel and four to six feet of india-rubber tubing about half an inch in diameter. The jug from which the fluid is poured into the funnel should be held about five feet above the patient. It should take from fifteen to thirty minutes to inject two to three pints of saline fluid, the amount usually required, or even more, up to five or six pints. Care must be taken, while the fluid is being injected, that no air enters, that there is no kinking or blocking of, or leakage from, the apparatus employed. The chief guides are the return of the pulse, with increase in volume and diminution in rate (say a fall from 130 to 90), return of colour and fulness to the face, increase in consciousness, &c. The operation having been completed, the remaining ligature is tied just below the opening in the vein, and the little wound closed and dressed with aseptic precautions. Any thick scar in front of the elbow-joint will embarrass its movements.

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* Commenting on this step, the Editor of the *Lancet* expressed his doubts as to whether much benefit can be expected from it, owing to the limited quantity of blood, and, therefore, the small corresponding percentage of the poison, which can be withdrawn.

† The use of milk, which has been employed by some—*e.g.*, Dr. Thomas, of New York—as safer and more nutritious than saline infusion, should be rejected absolutely. Both claims are quite unfounded for infusion purposes. Dr. Schäfer (*loc. supra cit.*) found that the injection of milk, after dogs had been reduced by bleeding to an almost lifeless condition, caused a temporary rise in the blood-pressure but no permanent benefit. After death the blood corpuscles were found to be disintegrated, and the blood swimming with bacteria.

Where the necessary apparatus cannot be procured, or in cases of severe hæmorrhage where all the bleeding points cannot be controlled, and where the injection of saline fluid will thus defeat the only means of arresting the bleeding, *e.g.*, clotting, one or two pints may be very slowly injected into the cellular tissue of the axillæ.

TRANSFUSION.

As it is still disputed how far transfusion of blood is useful in such diseases as pernicious anæmia, this operation will be described here, though it is clear that in the very great majority of indications it has been replaced by infusion of saline solution, chiefly on account of the difficulty with which sufficient quantity of blood is obtainable.

With regard to transfusion in pernicious anæmia, Dr. Hunter (*loc. supra cit.*) spoke as follows: "In idiopathic anæmia, pernicious anæmia, and leucocythæmia, transfusion of blood can, in my opinion, never be indicated. In both the condition of the blood is the result of changes in the blood-forming or blood-destroying processes, or both. In leucocythæmia the disturbance is one of blood-formation in the first instance, evidenced by the increase of the leucocytes of the blood, while the diminution in the number of the red I find to be due in great part to excessive blood-destruction, probably induced by the activity of the leucocytes. In pernicious anæmia, the condition of the blood is mainly the result of excessive destruction. Transfusion of blood under such circumstances is not unattended by dangers, as we have seen, but is followed in most cases by rapid destruction of the red corpuscles, as evidenced by fever, sometimes by hæmoglobinuria, occasionally also by increase in the slight icterus which so frequently marks the progress of the disease." On the other hand, at a meeting of the Edinburgh Medico-Chirurgical Society (*Lancet*, vol. i. 1892, p. 24), Dr. Brakenbridge and Dr. Affleck claimed successful cases.

Dr. J. R. Philpots (*Brit. Med. Journ.*, vol. i. 1894, p. 162) also mentions a successful case in which the transfusion was performed by Mr. C. E. Jennings. Here 16 ounces of blood were transfused, the blood mingling "in its passage with about 10 ounces of saline fluid, and about 16 ounces of saline fluid were infused into the donor's veins to replace the blood given."

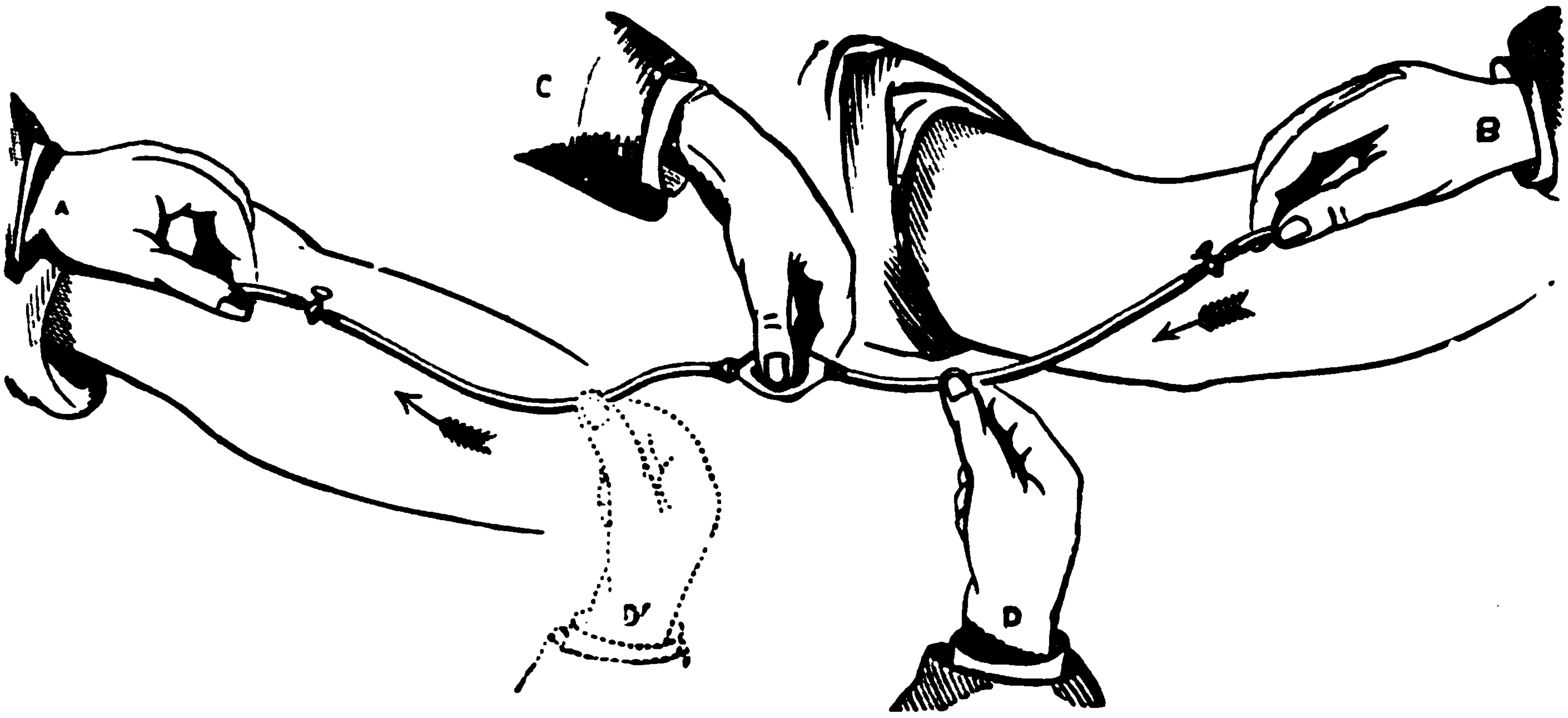
One other condition in which transfusion of blood, aided perhaps by infusion of saline solution, may be beneficial, is poisoning by carbonic oxide gas. Here, perhaps, it would be well to get rid of some of the poisoned blood by a preliminary blood-letting.

There are two methods—A. Direct, in which blood is conveyed directly from one person into another; and B. Indirect, in which blood separated from its fibrin, or some other fluid, is thrown in.

Direct.—Owing to want of space I shall describe this alone. It is probably preferable to inject blood without exposure to air and without manipulation in the few cases in which this method may be called for.

Method.—(Fig. 53.) DR. AVELING'S, MODIFIED BY MR. CRIPPS.—As I have only space for one here, I shall describe that with which I am most familiar. It is simple and inexpensive,* and has the advantage of measuring the blood sent—viz., two drachms at each squeeze of the bulb.

FIG. 53.



A and B are the hands of assistants holding the afferent and efferent tubes and the lips of each venæsection wound together. The cannulæ being inserted into the veins, the bulb and tubing, filled with warm saline solution, and kept so by the taps or clips, are fitted into the cannulæ. Then the taps are turned or the clips removed, and the tubing compressed by D, and the bulb squeezed by C. The tube is then squeezed by shifting D to D'. The bulb then expanding draws in blood, when the manipulation just described is repeated. The bevelled end of the afferent tube is so made that it may slip easily into the collapsed vein of the patient. (Aveling, *Obst. Trans.*, vol. vi., May 4, 1874.)

The veins being exposed and probes passed beneath them, the apparatus is filled with a warm solution of sodium chloride, and a clip placed at either end. The arms of receiver and donor being in the position given above, the vein of the receiver is opened with sharp scissors, and, pressure being made just below the opening in the vein, so as to prevent blood obscuring the opening, the cannula is inserted. The other cannula is then inserted into a vein of the giver, and both are held steadily by an assistant. Transfusion is then performed as follows:

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* I may remind my readers that, as in the case of all india-rubber instruments, this, unless kept carefully and looked at from time to time, is liable to be found cracked and useless at the moment of need. I believe the only means of really ensuring the preservation of india-rubber is to keep it under water. Mr. Cripps (*Dict. of Surg.*, vol. ii. p. 660) has removed one source of clotting by replacing with clips the taps shown in Fig. 53.

"The clips having been removed from the tube at either end, the operator makes the necessary valve to prevent regurgitation by compressing, with the finger and thumb of one hand, the tube between the central ball and the giver. He then slowly squeezes the ball, with the effect of driving the water it contains gently into the vein of the recipient; then, having compressed the tube between the ball and the recipient, he removes the finger and thumb from off the tube on the opposite side, allowing the ball to expand with the blood coming into it from the arm of the giver. When the ball is full the manipulation just described is repeated, and the blood passes into the vein of the receiver. In this manner, each time the ball is compressed, two drachms of blood are injected into the veins of the patient. Should the syringe appear to become blocked,* or work unsatisfactorily, it can be detached and washed out without removing the cannulæ from the veins."

Risks and Dangers of Transfusion.—Amongst these are:

1. Emboli and their results.

Dr. W. Hunter (*loc. supra cit.*, pp. 306, 307) points out that very grave symptoms, due to widespread thrombosis and spasm of the capillaries, especially of those of the gastro-intestinal mucous membrane and lungs, may follow on transfusion of blood with or without sodium phosphate. The most frequent of these are abdominal pain, diarrhœa, albuminuria, hæmoglobinuria, &c. Furthermore, one great feature of defibrinated blood, however obtained, is the uncertainty of its action. It is sometimes quite harmless, at others highly dangerous—this result being entirely independent of the quantity injected or the care taken in injecting it.

It has been suggested that some saline solution having the power of delaying the coagulation of blood—*e.g.*, sodium phosphate—should be added to the blood before it is transfused (Braxton Hicks, *Guy's Hosp. Rep.*, vol. xiv.). Dr. W. Hunter (*loc. supra cit.*, p. 305) condemns the use of this salt. He is of opinion that the use of even a ½ per cent. solution of sodium phosphate will cause red corpuscles to break up within twenty-four hours, and that the use of this salt along with blood will not prevent the occurrence of those capillary thromboses which are known to follow on transfusion of blood by itself.

Except for those cases where infusion of saline solution has failed, or where, as in pernicious anæmia, it is desired to inject blood and to add to the amount injected, it is not likely that the employment of sodium phosphate will be continued.

2. Evidence of blood being thrown in too rapidly for the system of the receiver—*e.g.*, headache, flushing, præcordial oppression, &c.

3. Perhaps septic absorption, if the blood has been exposed too long.

4. Many of the risks already given under the head of "Venæsection" (p. 104) will, of course, be present here also.

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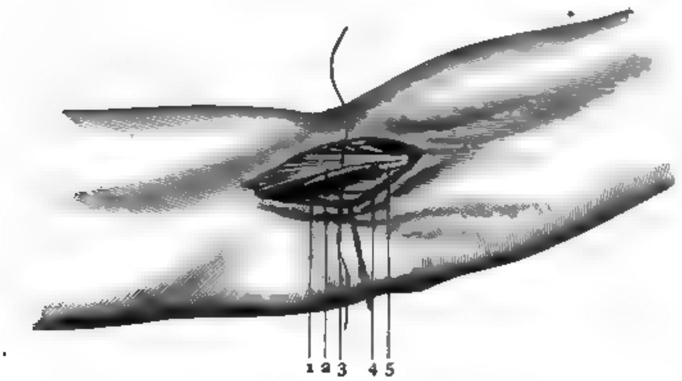
* A case in which this occurred will be found related by Dr. Hoggan, *Brit. Med. Journ.*, 1877, vol. ii. p. 726.

LIGATURE OF THE BRACHIAL ARTERY AT THE BEND OF THE ELBOW (Figs. 40, 54 and 55).

This operation, common enough fifty years ago owing to the frequency of venæsection and the facility with which the brachial artery was wounded, will be briefly described here.

Indications.—(1) Wound of the artery, especially after venæsection, or tenotomy of the biceps tendon (here a ligature above and below the wound will be required), or a flying chip of metal (Williamson, *Brit. Med. Journ.*, vol. ii. 1896, p. 1511). (2) Traumatic aneurysm, whether arterio-venous or no, also occurring after accidents such as the above.

FIG. 54.



Ligature of the brachial artery at the bend of the elbow. 1, Artery surrounded by its venæ comites, from the inner of which a branch passes to 4 (basilic vein). 2, Bicipital fascia. 3, Median nerve. 4, Basilic vein. 5, Biceps tendon. (Too much of the artery is shown cleaned.)

GUIDE.—The inner side of the biceps tendon.

RELATIONS :— IN FRONT.

Skin; fasciæ; bicipital fascia; median basilic vein. Branches of internal and external cutaneous nerve.

OUTSIDE.
Biceps tendon.
Vena comes.

Brachial artery
at bend of elbow.

INSIDE.
Median nerve.
Vena comes.

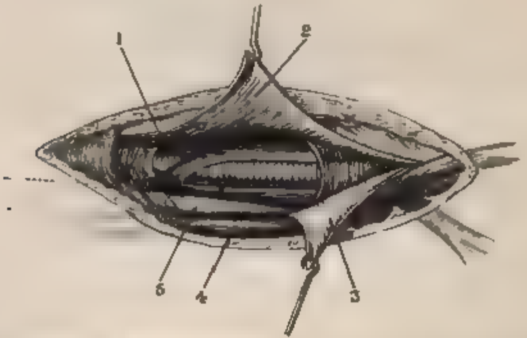
BEHIND.
Brachialis anticus.

Operation (Figs. 40, 54 and 55).—The limb being steadied, with the elbow slightly flexed, the site of the biceps tendon should be defined, and also that of any large veins, by making pressure a little above the proposed site of ligature. An incision about 2 inches long is then made, a little to the inner side of the biceps tendon, through the superficial fascia carefully, so as to avoid the median basilic vein and its companion, the internal cutaneous nerve. If these are seen, they must be drawn inwards. The deep fascia is then divided on a director, this and the semilunar fascia of the biceps, which strengthens it, being interfered with as little as possible. The artery, with its venæ comites, lies directly underneath. The needle should be passed, after the veins are separated and the artery cleaned, from within outwards, so as to avoid the median nerve, which lies more deeply on the inside.*

In the case of traumatic aneurysm, arterio-venous or no, resisting other treatment, the old operation of placing double ligatures† will be preferable to the Hunterian one, which runs the risk of overlooking the possibility of a rather higher division than usual of the brachial into radial and ulnar. If much hæmorrhage is expected, the brachial should be compressed about the middle of the arm with an Esmarch's bandage, or the vessel controlled by a reliable assistant. The median basilic vein will, in many cases of arterio-venous aneurysm, be found much dilated by the entrance of arterial blood. Occasionally it has been obliterated. In ordinary traumatic aneurysm, the sac should be cut away with scissors, after the artery above and below has been secured.

This operation at the bend of the elbow should always be performed with the utmost carefulness at the time, and pains taken with the after-treatment, so as to ensure the minimum of disturbance and the smallest amount of cicatrix, and thus to interfere as little as possible with the movements of the elbow.

FIG. 55



Incision for ligature of brachial artery at the bend of the elbow (left), shown dissected. 1, 2, 3. Tendon of biceps and outer and inner flaps of bicipital fascia. 4. Basilic vein. 5. Median nerve. The artery is seen surrounded by its two venæ comites, the sheath having been freely removed. (Farabeuf.)

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* If it be needful to prolong the incision downwards so as to secure the upper end of the radial or ulnar, the bicipital fascia must be divided more freely, and the median basilic vein secured if it cannot be drawn to one side.

† Here ligatures will be required above and below the communication with the vein in the case of aneurysmal varix, and above and below the sac if the surgeon is dealing with a varicose aneurysm. It will be better (the artery being commanded above) to open the sac, and thus find the apertures into the artery by the aid of a small bougie. As Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 92) points out, the other plan of attempting to find and tie the artery without opening the sac presents these difficulties—viz., that the artery is surrounded by dilated and closely packed veins, and that below the sac it is of small size.

CHAPTER V.

OPERATIONS ON THE ARM.

LIGATURE OF BRACHIAL ARTERY (Figs. 40, 54 and 56).

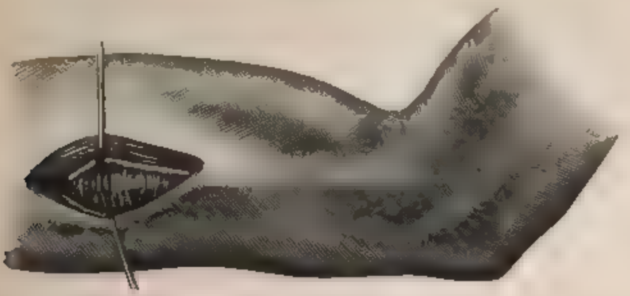
his is performed (*a*) in the middle of the arm, and, much more rarely, b) at the bend of the elbow, the operation last described.

a) In the Middle of the Arm (Fig. 56).

Indications.

1. Chiefly wounds of the palmar arch, resisting pressure (p. 27). 2. Wound of the artery itself by a penknife,[*] bayonet, bullet, &c.

FIG. 56.



The upper hook draws aside the biceps and the median nerve, the lower, the basilic vein and the triceps. The inner vena comes is seen in the bottom of the wound. The sheath of the artery has been opened and a small portion cleaned ready for the passage of the ligature.

3. Gunshot wound of the elbow, leading to secondary hæmorrhage resisting other treatment. 4. Angeioma of hand.

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[*] Mr Sheild (*Lancet*, 1887, vol. i. p. 978) has recorded a case of stab wound of the rachial, with many points of interest. A penknife wound had reached the artery by passing from without inwards through the biceps. The bleeding was arrested by pressure. The wound healed, and twenty days later a fall caused the cicatrix to give way, profuse hæmorrhage following. Esmarch's bandage being applied, a free incision was made and the bleeding point found by searching with a bent probe, the end of which passed into an opening in the brachial artery. Ligatures were applied above and below. Owing to the swelling of the arm no sutures were used. A good recovery took place.

In March 1891 I tied first the brachial, and, five months later, the radial and ulnar arteries, for a congenital angeioma with much erectile tissue affecting all the fingers and the palm of the hand in a girl aged 18. By the first operation the vascularity was quickly reduced; the second, aided by catgut setons, was followed by very marked shrinking, and, ultimately, a complete cure.

5. Wound of one of the arteries of the forearm, followed by severe hæmorrhage, a sloughy condition of the parts preventing ligature of the vessel above and below the wound.

In the year 1882 a patient came under my care for secondary hæmorrhage from a wound of the forearm, inflicted by the bursting of a gun in rook-shooting. The parts were much swollen and sloughy; the ulnar artery in its middle third, from which the hæmorrhage was coming, was greenish in colour, and apparently not in a condition to hold a ligature. A good recovery, with no further hæmorrhage, took place after ligature of the brachial in the middle of the arm.

In 1885 I had occasion again to tie this artery, for hæmorrhage occurring repeatedly a few days after a suppurating palmar bursa had been opened in the usual way, above and below the anterior annular ligament. The patient recovered with a weakened limb.

6. Traumatic and spontaneous aneurysm. In traumatic aneurysm, whether of the brachial or the arteries of the forearm, the old operation is preferable to the Hunterian, as the sac is often imperfect.

Dr. H. Bousquet records (*Congrès Franç. de Chir.*, 1895, p. 741) a case of traumatic aneurysm* of the forearm, dating to a gunshot injury, cured by excision of the sac.

A labourer, while poaching, received a charge of No. 6 shot, which, entering in the lower third of the forearm, passed obliquely upwards almost as high as the elbow. The wound healed in about six weeks. Evidence of an aneurysm became manifest thirteen days after the injury, but operative treatment was refused. Six months after the accident, an Esmarch's bandage having been applied, an incision was made over the swelling, which was now of a pyriform shape, and reached from the middle of the arm to the lower third of the forearm. The brachial artery having been tied as low down as possible, the aneurysm was separated from the adjacent structures. In spite of much care, its walls, which were very thin, gave way at several spots. Its interior was filled with passive clot. Its lower extremity was embedded in the cicatrix of the wound. The aneurysm probably sprang from the arteries of the forearm near their origin, perhaps also in the brachial. The removal of the aneurysm left a large cavity, of which the floor was formed by the interosseous membrane, and the sides by muscles of the forearm. Several vessels were tied before and after the removal of the Esmarch's bandage. As it was impossible to bring so large a wound together, it was plugged with iodoform gauze. The patient recovered with a useful limb.

With regard to spontaneous aneurysms, it is well known that these are very rare in the upper extremity, and usually associated with cardiac disease. When this complication is present, ligature will only be thought of when the aneurysm is rapidly increasing, or causing painful pressure upon a nerve. Cocaine may be useful here.

LINE.—From the junction of the middle and anterior thirds of the axilla, along the inner edge of the coraco-brachialis and biceps, to the middle of the elbow triangle. This line is of especial importance, when, owing to swelling, &c., the edge of the biceps is difficult to make out.

GUIDE.—The above line and the inner edge of biceps.

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* The aneurysm is also described as arterio-venous, but no evidence of this is given. The account of the vessels affected is practically *nil.*

Relations in arm:— IN FRONT.

Skin; fasciæ; branches of internal and external cutaneous nerves.
Median nerve* (about the centre of the arm).

OUTSIDE.		INSIDE.
Coraco-brachialis (above).		Ulnar nerve.
Biceps.	Brachial artery in arm.	Internal cutaneous nerve.
Vena comes.		Vena comes.
		Basilic vein, superficial to deep fascia in lower half, beneath it above, usually.

BEHIND.

Triceps (middle and inner heads); coraco-brachialis; brachialis anticus.
Musculo-spiral nerve and superior profunda artery (above).

Collateral Circulation.

(*a*) If the ligature be placed above the superior profunda, the vessels chiefly concerned will be—

Above.		Below.
The subscapular The circumflex	with	The superior profunda.

(*b*) If the ligature be placed below the superior profunda—

Above.		Below.
The superior profunda	with	The radial recurrent. The posterior ulnar recurrent. The interosseous recurrent. The anastomotica magna.

(*c*) If the ligature be placed below the inferior profunda—

Above.		Below.
The superior profunda The inferior profunda	with	The radial recurrent. The ulnar recurrents. The interosseous recurrent. The anastomotica magna.

Abnormalities.—These are so far from infrequent† that the surgeon must be prepared for the following:

1. The artery being in front of the nerve.
2. A high division of the artery. According to Mr. Quain, in one out of every five cases there were two arteries instead of one in some part, or in the whole, of the arm. The point of bifurcation is thus described by Gray: "It is most frequent in the upper part, less so in the lower part, and least so in the middle, the most usual point for the application of a ligature; under any of these circumstances, two large arteries would be found in the arm instead of one. The most frequent (in three

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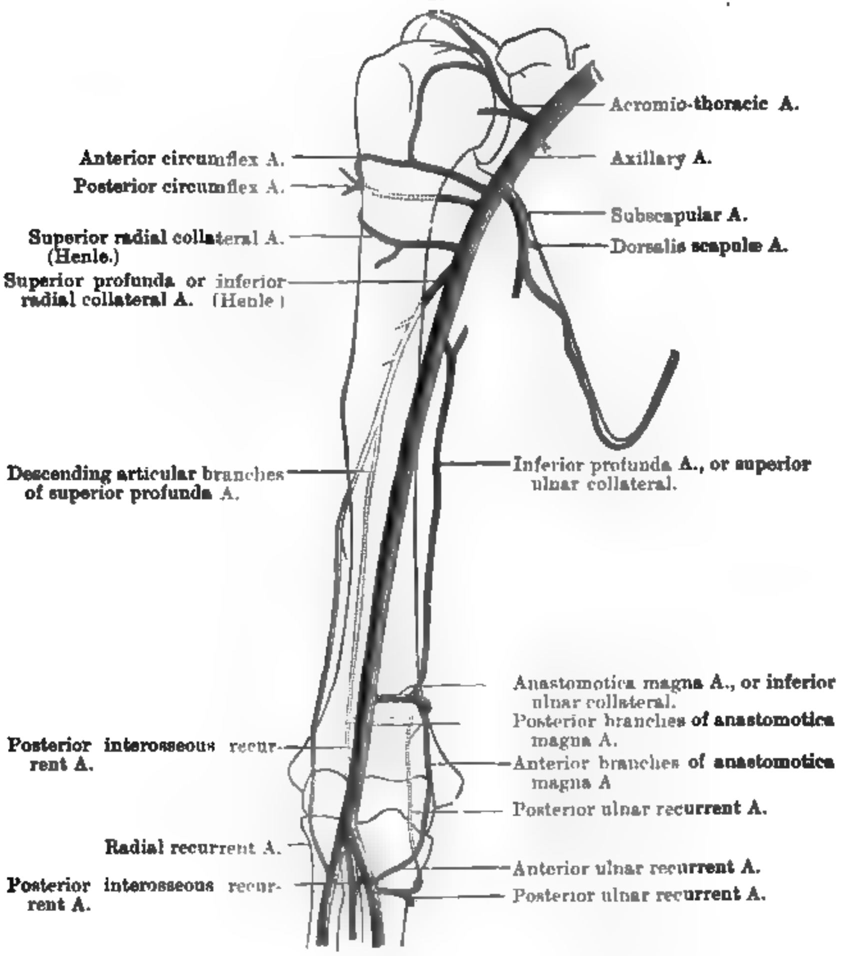
* In one out of every six cases the median nerve lies under the artery (Skey, *loc. supra cit.*, p. 269).

† Numerous instances of these are figured by Mr. Reeves in the Appendix to his *Human Morphology*, vol. i. p. 692 *et seq.*

out of four) of these peculiarities is the high origin of the radial. That artery often arises from the inner side of the brachial, and runs parallel with the main trunk to the elbow, where it crosses it, lying beneath the fascia; or it may perforate the fascia, and pass over the artery immediately beneath the integument."*

3. The artery may be partially covered by a muscular slip given off from the pectoralis major, biceps, coraco-brachialis, or brachialis anticus.

FIG. 57.


Acromio-thoracic A.
Anterior circumflex A.
Axillary A.
Posterior circumflex A.
Subscapular A.
Superior radial collateral A. (Henle.)
Dorsalis scapulæ A.
Superior profunda or inferior radial collateral A. (Henle.)
Descending articular branches of superior profunda A.
Inferior profunda A., or superior ulnar collateral.
Anastomotica magna A., or inferior ulnar collateral.
Posterior branches of anastomotica magna A.
Posterior interosseous recurrent A.
Anterior branches of anastomotica magna A.
Posterior ulnar recurrent A.
Radial recurrent A.
Anterior ulnar recurrent A.
Posterior interosseous recurrent A.
Posterior ulnar recurrent A.

Anastomosing branches of axillary and brachial arteries. (Mac Cormac.)

4. One or more slender vasa aberrantia may be met with in the arm, passing from the axillary or the brachial to one of the arteries in the forearm.

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* The possibility of this superficial position of the radial or ulnar should always be remembered when venæsection, or ligature of the brachial, at the elbow is about to be performed. See also the footnote, p. 103.

Operation (Fig. 56).—The arm being extended and abducted from the side, with the elbow-joint flexed and supported* by an assistant, the surgeon, sitting between the limb and the trunk,† makes an incision 2½ inches in length along the inner border of the biceps, beginning from below or above as is most convenient, going through the skin and fasciæ, and exposing just the innermost fibres of the muscle.‡ This is then drawn outwards with a retractor, the median nerve next found and drawn inwards or outwards with an aneurysm-needle, and the artery defined and sufficiently cleaned, when the ligature is passed from the nerve. In doing this the basilic vein and the venæ comites, which increase in size as they ascend, must be carefully avoided.

I would point out that the brachial artery is by no means so easy a vessel to tie as might be supposed from its superficial position. This is especially the case when the artery is concealed by the median nerve at the point where it is sought, and when its beat is feeble and the vessel itself small and but little distended after repeated hæmorrhage lower down.§

AMPUTATION OF THE ARM (Figs. 58, 59 and 60).

Indications.—Amongst these are:

1. Accidents, *e.g.*, compound fractures, machinery accidents, &c., which do not admit of any part of the forearm being saved, or of amputation at the elbow. The advisability of amputation in such cases is discussed, once for all, in the chapter on the "Antiseptic Treatment of Compound Fractures." 2. New growths involving the forearm, and not admitting of extirpation. 3. Disease of the elbow-joint not admitting of excision, or in which this operation has failed (pp. 58, 92). 4. Gunshot injuries of the upper part of the forearm, elbow, and arm not admitting of conservative treatment or excision. So inestimable is the value, even when only partial, of the hand, and so good are the results of conservative treatment and secondary amputation, that the tissues must be almost disorganised for the surgeon to think of primary amputation here.‖

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* Mr. Heath has pointed out (*Operative Surgery*, p. 18) that if the arm, when at a right angle to the body, be allowed to rest upon the table, the triceps is pushed up, and, displacing the parts, may bring into view the inferior profunda and the ulnar nerve instead of the brachial and the median nerve.

† This is, to my mind, a much more comfortable position than standing on the outer side and looking over.

‡ Authorities differ as to this step. I strongly advise the operator to avail himself of this guide. If it be done carefully, and the wound kept aseptic afterwards, it can do no harm. The fibres of the muscle are a distinct help, and (as stated above) ligature of this artery is not so easy a one as it would appear.

§ This was so marked in the last of my three cases mentioned at p. 114, that, when I exposed the vessel, several bystanders felt certain that it was not the brachial, but one of its branches.

‖ Dr. Otis, writing in 1883 (*loc. supra cit.*, p. 916), thus summed up on the question of conservative surgery, excision, and amputation in gunshot injuries of the elbow-joint:—"The practical conclusions that appear to be deducible from the foregoing investigations are—(1) That in shot wounds in young healthy subjects attended with slight injury of the articular extremities of the bones of the elbow, such as fractures of the olecranon, of the outer condyle, or of the trochlea, without much splintering and without lesion of

The following (Reclus, *Cong. Franç. de Chir.*, 1895, p. 682) is a good instance of what conservative surgery may effect, should the patient refuse to submit to amputation, or decide to face the risk of blood-poisoning, tetanus, &c., when these dangers have been fully put before him.

In a man, æt. 53, whose left upper limb had been caught between a lamp-post and a furniture van, the middle of the forearm was shattered as follows:—The skin was stripped off over the whole circumference, save at one spot on the ulnar border. All the muscles, anterior, posterior, and external, were destroyed down to the bone, and formed above and below retracted masses bounding a deep gap, at the bottom of which lay the radius and ulna, each broken into three fragments, some of which were overriding the others. The large vessels and nerves had alone escaped; the sensibility of the hand was not interfered with. The wound having been thoroughly cleaned—dirt, clots, débris of fasciæ, tendons, and muscles, and some splinters of bone quite bare of periosteum having been removed—the soft parts were in a measure drawn together by means of stout silk, the sutures taking up muscles and skin. The fragments of the bones were got into place with difficulty. The wound was dressed once every three weeks. Consolidation of the bones was not obtained until the end of four months. But the result was surprising. The forearm was useful, the continuity of the muscles being established. The thumb was free and active, and opposed itself very easily to the fingers, which were becoming less stiff every day. Here amputation above the elbow-joint was the only alternative.

Amongst the special conditions which will have to be considered are the size and character of the projectile, the gravity of the laceration of the soft parts, the amount of longitudinal splintering of the bones, the extent of lesions to the vessels and nerves, and the degree to which conservative measures can be adopted in the absence of hospital facilities or of easy transportation.*

If the surroundings of the surgeon and patient admit of it, attempts will nowadays be made to suture the nerve ends, especially when only

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the important vessels and nerves, it is justifiable in many instances to attempt an expectant conservative treatment, keeping the injured extremity in entire rest, after removing any detached fragments or foreign bodies, in a semi-prone and very flexed position, employing ice or other cold applications. If the inflammatory action becomes intense, the wounds should be freely enlarged and the joint-cavity freely laid open, and easy escape provided for the altered wound secretions by position and drainage-tubes. The strength should be sustained by a tonic regimen, and when the inflammatory stage has completely abated, and not before, if healing is slow, secondary excision or amputation may be hopefully resorted to. Unless all the favourable conditions mentioned are present at the outset, it would be safer to resort to primary excision or to amputation. (2) In grape-shot comminutions with lesions of the principal vessels or nerves, amputation should be practised immediately after the reception of the injury. (3) In severe shot-fracture, without extensive lesion of the soft parts, the joint should be freely exposed by a longitudinal posterior incision, and the full extent of the fracture ascertained. Unless there is extraordinary fissuring, the injured joint-ends should then be sawn off as close to the limits of injury as possible, save that the bones of the forearm should be shortened to the same level. If the splintering extends very far, or if there is reason to believe that the humeral vessels are injured though not wounded, the incision should be so modified as to convert the operation into an amputation."

* On this point Dr. Otis writes (*loc. supra cit.*, p. 811): "The surgeons, doubtless, sometimes yielded to what John Bell called 'an argument of necessity as well as of choice, and limbs, that in happier circumstances might have been preserved, had often, in a flying army or a dangerous campaign, to be cut off,' since 'it is less dreadful to be dragged along with a neat amputated stump than with a swollen and fractured limb, where the arteries are in constant danger from the splintered bones.'"

one or two of the chief trunks are involved. The old doctrine, that shot-fracture of the humerus with wound of the brachial artery imperatively indicates amputation, no longer holds good.

Methods.

i. Skin flaps with circular division of muscles—(*a*) antero-posterior flaps, (*b*) lateral flaps. ii. Transfixion flaps, usually antero-posterior. iii. Skin and transfixion flaps combined. iv. Circular. v. Single flap. vi. Teale's method.

i. **Skin Flaps with Circular Division of Muscles.**—This should be made use of in bulky muscular arms.

(*a*) ANTERO-POSTERIOR FLAPS.—The brachial having been controlled,* and the arm supported at a right angle to the body, the surgeon stands outside the right and inside the left limb, with the forefinger and thumb of his left hand marking the site of intended bone-section (Fig. 59). He then enters the knife on the side of the limb farthest from him, carries it first down 3, 3½, or 4 inches, according as he is going to make one flap longer than the other or not,† next across the limb, with square edges, and up the side nearest to him, to the point opposite to that from which the incision started. Then passing the knife under the limb, he marks out a posterior flap, usually somewhat shorter than the anterior. These flaps, consisting of skin and fasciæ, are now dissected up, the muscles cut through at the flap-base with a circular sweep, and the bone sawn through as high as possible. Especial care should be taken here, as in forearm amputations, to divide the nerve-trunks square and high up.‡ In tying the main arteries, each must be thoroughly separated from its accompanying nerve.

(*b*) LATERAL FLAPS.—This method may be made use of, one flap being cut longer than the other, when the skin is more damaged on one side.

The surgeon, standing as before, marks the site of bone-section by placing his left forefinger and thumb, not now on the two borders of the arm, but on the middle of the anterior and posterior surfaces of the limb. Looking over, he enters his knife at the latter spot, and cuts a well-rounded flap, ending on the middle of the anterior aspect, and then from this point, without removing the knife, another flap is marked out by a similar incision ending at the middle of the back of the arm. The flaps are then dissected up, and the operation completed as before.

ii. **Transfixion Flaps, usually Antero-posterior** (Fig. 58).—In an arm of moderate size, or where rapidity is required, as in warfare or in cases of double amputation, this method may be made use of. The surgeon, standing as before,* and with his left hand marking the flap-base, and lifting up the soft parts anterior to the humerus so as to get in front of the brachial vessels, and thus avoid splitting them, sends his knife across the bone and in front of the above vessels, and makes it emerge at a point exactly opposite; he then cuts a well-rounded flap, about 3 inches long, with a quick sawing movement, taking care, after he feels the muscular resistance cease, to carry his knife on a little, so as to cut the skin longer than the muscles, the knife being finally brought out quickly and perpendicularly to the skin. The flap being then lightly raised, without forcible retraction, the knife is passed behind the bone at the base of the wound already made, and a posterior flap cut similar to the anterior, but somewhat shorter. Both flaps are then retracted, any remaining muscular fibres divided with circular sweeps of the knife, and the bone exposed a little above the junction of the flaps. The saw is then applied after careful division of the periosteum. The brachial artery will either be found in the posterior flap, or if, as both flaps are made, the soft parts are drawn a little from the humerus, the main artery and nerves will be left, and must be cut square with the circular sweeps of the knife.

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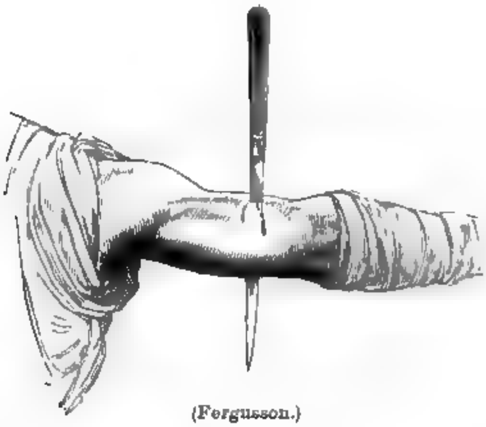
* With an Esmarch's bandage usually; in amputation high up, either the axillary must be controlled by elastic tubing applied by a modification of the method given at p. 140, or the subclavian must be controlled by a reliable assistant, or the vessels secured after the manner given at pp. 141, 143.

† If the flaps are cut of equal length, the cicatrix will be opposite, and perhaps adherent to, the bone; this is very undesirable, though of less importance in a stump of the upper than of the lower extremity.

‡ In an amputation which passes through the musculo-spiral groove, great care must be taken to divide completely the nerve lying in this, before the bone is sawn. The depth of this groove varies much. When it is considerable, the nerve may easily escape division and be frayed by the saw, giving rise, if overlooked, to a most painful, bulbous end.

Fig. 58.



(Fergusson.)

If it be preferred, lateral flaps can be made by transfixion (Fig. 58), one, of course, being cut longer than the other if this is rendered desirable by the condition of the soft parts.

iii. **Combined Skin and Transfixion Flaps** (Fig. 59).—This, a very speedy and efficient method, may be made use of here. An anterior flap of skin and fasciæ, about 3 inches long, having been marked out (p. 119) and dissected up, the bulk of the soft parts behind the bone are drawn a little away from it, the knife passed behind the humerus, and a posterior flap, somewhat shorter, cut by transfixion.

iv. **Circular** (Fig. 60).—Owing to the moderate size of the limb, and its circular shape, this is the place, above all others, where this method can be made use of, especially in limbs which are not very bulky. Whether he make use of it in after-life or not, the student should always practise circular amputation here on the dead subject.

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* In Fig. 58 the surgeon is supposed to be standing outside the left arm.

Standing as before, or on the outer side of either limb, the surgeon, with his left hand, draws the skin up strongly, and passes his knife under the arm, then above, and so around it, till, by dropping the point vertically, the back of the knife looks towards him, and the heel rests on the part of the arm nearest to him. A circular sweep is then made round the limb, the completion of this being aided by the assistant in charge of the limb, who should rotate it so as to make the tissues meet the knife. A cuff-like flap of skin and fascia* is then raised, for 2½ or 3 inches, with light touches of the knife, these being especially needed along the lines of the intermuscular septa. In a very muscular arm it may be difficult to raise the skin as directed, and it will be sufficient here for an assistant to retract it evenly all round as it is freed by the knife. When the skin has been sufficiently folded back or retracted, the muscles are cut through close to the reflected skin.† The cut muscles are next retracted by the operator's left hand, and the remaining soft parts, with the main vessels and nerves, are severed clean and square.‡

FIG. 59.

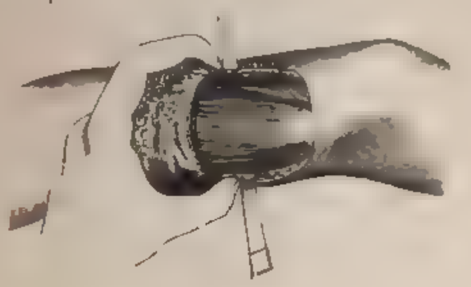
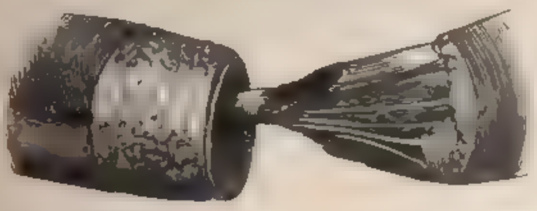


FIG. 60.



The bone is then freed for ¾ inch, and, the periosteum having been divided, is sawn through as high as possible.

v. Single Flap. This, preferably an anterior, is cut by transfixion, and so arranged, if possible, as not to include the large nerves (Malgaigne).

vi. Teale's Method.—This is, however, expensive of important parts.

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* See footnote, p. 77.

† By some it is advised to cut the biceps rather longer than the rest, owing to its retracting more, as it is not attached to the humerus.

‡ See the remarks (footnote, p. 119) on the importance of securing thorough and clean division of the musculo-spiral nerve when the amputation passes through the groove.

Height of Section of the Bone.—If possible, the head of the humerus should be left *in situ*. This not only leaves a far more shapely stump, but, as pointed out by Farabeuf, quoting from Percy, it furnishes a useful point of attachment for an artificial limb, and one well fitted to bear pressure in certain occupations. Farabeuf (*loc. supra cit.*, p. 350) alludes to the necessity of preserving, in amputations high up, some part of the insertion of the pectoralis major in order to counteract the tendency to abduction of the stump.

EXCISION IN CONTINUITY OF THE SHAFT OF THE HUMERUS.

This operation has been especially discussed in reference to gunshot wounds. By the term "excision in continuity," deliberate removal of portions of the shaft of the humerus—*e.g.*, 2–6 inches—the periosteum being preserved as far as possible, is meant; such operations as incision and removal of splinters, operations for necrosis and for pseudo-arthrosis, should be excluded.

Dr. Otis* thus writes of this operation:

> "I cannot discern that the experience of the war lends any support to the doctrine of the justifiability of operations of this nature except in very exceptional cases. The numerical returns, and the necessarily abbreviated summaries, may appear, at first glance, to represent the results in a favourable light, but a more precise analysis reveals most lamentable conclusions. . . . . The mortality rate is nearly double that observed in the cases treated by expectant measures, and more than 12 per cent. higher than the fatality in a larger series of primary amputations in the upper third of the arm. Moreover, in the 477 cases of recovery there were no less than 99 instances in which 'no bony union' was reported, and 65 others recorded as examples of 'false joint.' There were also amongst the cases reported as 'successful' 37 instances of consecutive amputation of the arm. Recourse was had to ulterior exarticulation or amputation in 64 patients, of whom 27 perished.
>
> "Such evidence warrants the assertion that early excision in the continuity of the humerus after injury can seldom be justifiable, a conclusion at which European surgeons had already arrived from the experience of the Schleswig-Holstein and Danish wars, and which had been confirmed by more recent observations. The coaptation of the resected ends of the bones by silver wires was sometimes practised, with few illustrations of favourable results. Examination of the details of many of the formal primary excisions in the shaft strengthens the impression that they were for the most part unnecessary and injurious."

Causes of Failure after Excision of the Humerus in Continuity.—Amongst these are:

1. Osteo-myelitis and pyæmia. 2. Secondary hæmorrhage. 3. Secondary necrosis. 4. Non-union, leading to a limb which dangles† or is flail-like, and is more or less useless in spite of a support.

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* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 695 *et seq.* In Circular No. 3, p. 223, seven "successful" cases are briefly reported. In one of these, two months after the removal of three inches of the shaft (the operation having been performed for caries a year after a gunshot injury), bony union had taken place, and the functions of the hand and arm were well performed. The patient could lift 8 or 10 lbs., and the arm was still becoming stronger. The bone removed is said to have been completely denuded of its periosteum in its entire circumference, this membrane being probably thickened.

† There is a good illustration of this result in Fig. 506, *loc. supra cit.*, p. 682. Further details are needed of the amount of use made of, and the ultimate advantage accruing from, the ingenious apparatus of Dr. Hudson, which was supplied to many of these cases.

While excision in continuity of the humerus is to be condemned as a primary operation, and while the same operation performed secondarily for necrosis may lead to a limb which is of little use without an artificial support, the following case of Prof. Macewen's (*Annals of Surgery*, vol. vi. No. 4, p. 301) shows what ingenuity and perseverance may effect in such cases, and proves that detached portions of bone deprived of their periosteum are capable of living and growing after transplantation:

A boy, æt. 2, had complete* necrosis of the shaft of his right humerus after suppurative periostitis. The necrosed bone was removed about nine weeks after the onset of the periostitis, leaving the layer of granulations covering the periosteum intact, and forming a tube, which was kept patent by dressings suitably inserted until the whole space had granulated up. No bone grew from the periosteum, except a small part next the proximal epiphysis where, at the outset, the periosteum was found covered by plaques of adherent osseous tissue. From the whole of the remainder there was no osseous deposition, the result being a flail-like arm. Fifteen months subsequently he returned to the Glasgow Royal Infirmary, his parents desiring that the arm should be removed, it being worse than useless, inasmuch as he required the other hand and arm to look after the flail-like one, which was constantly dangling in the way. The condition of the arm was as follows:—The bone had not increased in length since he left the hospital. When the limb was allowed to hang by the side, the measurement, from the tip of the acromion process to the distal extremity of the humeral shaft, was nearly 2 inches. The proximal fragment was conical, and tapering from the rounded head to a narrow spike-like extremity. From this to the condyles there was a complete absence of bone, there being nothing but soft tissues in the gap. The muscular power was good, but when he attempted to raise his arm a contraction of the muscles took place, the condyles being drawn towards the proximal extremity, while some fibres of the deltoid raised the spike-like process of the upper portion, causing it to project as if about to penetrate the skin. Here the action ceased, the soft parts in the gap appearing like a rope during the muscular contraction. He could not raise his forearm to his breast, the lever and fulcrum needed being wanting. It was determined to supply these by transplantation from other human bones. In the wards there were numerous cases of marked anterior tibial curves, from which wedges of bone had to be removed, and these were used as transplants. An incision was made into the upper third of the humerus, exposing the head of the bone. Its extremity, for fully ¼ inch, was found to be cartilaginous. The cartilaginous spike-like process was removed, leaving there a portion of bone, which measured 1¾ inch from the tip of the acromion. From this point a sulcus, about 2 inches long, was made, downwards, between the muscles. The former presence of bone was nowhere indicated, and there was no vestige of periosteum, the sole guide as to the correct position into which the transplant was to be placed being an anatomical one.† Two wedges of bone were then removed from the tibia of a patient, aged 6, affected with anterior curves. The base of these osseous wedges consisted of the anterior portion of the tibia, along with its periosteum. After removal they were cut into minute fragments with the chisel, quite irrespective of the periosteum. The bulk of the fragments had no periosteum adhering to them, they having been taken from the interior of the bone. They were then deposited in the muscular sulcus in the boy's arm, and the tissues drawn over them and carefully adjusted. The wound healed without pus-production.‡ Two months after, a portion of bone, 1 inch in length, and ¾ inch in thickness, was found firmly attached to the upper fragment of the humerus. In moving the finger from the head of the bone towards the graft, the latter could be easily distinguished by the sudden increase in the breadth. Now, instead of the former sharp spike, the upper fragment ended obtusely. Two other wedges of bone, of larger size than the first, were similarly dealt with, and inserted two months after the first. These filled up the gap in the arm to the extent of 4½ inches, the arm then measuring 6 inches in length. Soon the utility of the arm was greatly restored.

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* Prof. Macewen points out that it is probable that in the outset of this case the nutrient artery of the humerus was occluded or separated in the intensity of the suppurating process. The periosteum which remained not only did not produce bone, but, fifteen months later, appeared to have been completely absorbed.

† *I.e.*, the only guide was by recognising the relative positions which the muscles ought to occupy towards the humerus.

‡ The importance of this statement, and its effect upon the very happy result of the case, will not escape the reader.

Seven years afterwards the patient was seen and examined. The shaft of the humerus was found to have increased in length by 1¾ inch, being 7¾ inches, it had increased in circumference to a marked extent, and had assumed a somewhat irregular shape. The patient could use his arm for a great many purposes—taking his food, adjusting his clothes, and in many games.

In some remarks on this case Prof. Macewen advances the following arguments against the supposition that the new bone grew from old periosteum:—(1) If any of this had existed and possessed osteogenic power, it had ample time to reveal itself by osseous growth during the fifteen months which had elapsed between the removal of the dead bone and the transplantation of the new. (2) In opening the sulcus between the muscles for the reception of the transplants no periosteum or anything like fibrous membrane was seen. (3) The growth of the bone was at first only commensurate with the insertion of the transplants, there being no indication of any osseous growth in the vicinity of these which might have arisen from the supposed stimulation of the periosteum. (4) The solid humerus still retains the irregularities of shape which the transplants were permitted to assume in the tissues.

In the very rare cases in which the shaft of the humerus is to be resected, one of the following **methods** will suffice. In the first an incision is made, starting in the interval between the deltoid and the great pectoral, and carried down to the lower extremity of the deltoid; at this point it meets the external intermuscular septum, and is now carried more superficially (so as not to injure the nerve) till it gets into the interval between the triceps behind and the brachialis anticus and supinator longus in front, whence it is carried down to a point just above the external epicondyle. The nerve is made sure of by opening the intermuscular septum and drawing the triceps backwards and the brachialis anticus forwards, and then held carefully aside with an aneurysm-needle. Another method is known as that by a tunnel. The above incision is made above and below, but interrupted in the centre over the nerve. Through the upper incision the upper part of the humerus is removed, the saw being applied in the lower part of the wound, above the nerve. The lower end of the bone is got out through the lower incision, the saw being now applied below the nerve. The intermediate portion of the bone is now held firmly by lion-forceps and carefully peeled out, periosteal elevators being used in the upper and lower parts of the wound respectively.

Prof. Ollier warns those who would expect that periosteum methodically detached from the bone will always and completely reproduce the bone that it normally covered, that they are under a dangerous illusion. It can only be relied upon to do so in early life in young subjects, and when there has been no septic suppuration destructive to the bone-producing cells, and when some longitudinal splinters have been left attached within the periosteal sheath. A case of Billroth's (*Arch. f. klin. Chir.*, 1877) is quoted, in which, after removal of the whole humerus in a boy of 12, in spite of the easy separation and preservation of the periosteum, there was no reproduction of bone. On any attempt to fix or raise the arm, the limb folded upon itself and shortened, the forearm hanging like a flail. By the aid of a support the hand was rendered very useful. Prof. Ollier, therefore, urges that, whenever possible, a portion of the diaphysis should be left, and quotes cases of resection for gunshot injuries, by himself and Langenbeck (*loc. supra cit.*, pp. 133, 143), in which good results followed this step.

The subject of bone-grafting is referred to again in the chapter on "Operative Interference for Remedying Loss of Substance in the Long Bones." As the tibia is the bone most frequently concerned, owing to its being the seat, so often, of acute necrosis, comminuted fracture, and the removal of myeloid sarcomata, this chapter is given in the "Operations on the Lower Extremity."

OPERATIONS ON THE MUSCULO-SPIRAL NERVE.

Relief from Compression.—This nerve is, owing to its close connection with the shaft of the humerus, occasionally liable to compression by callus.* M. Ollier many years ago recorded a case of this kind successfully treated by surgery (*Gaz. Hebd.*, 1865, p. 515; *Syd. Soc. Bien. Retr.*, 1865–66, p. 294).

A man, aged 32, had suffered a compound fracture of the right humerus, through the musculo-spiral groove. Four months later, the fracture having firmly united, the extensors of the wrist and fingers were completely paralysed, and sensibility along the course of the radial was much diminished. The integrity of the functions of the triceps seemed to show that the lesion must be seated below the commencement at the musculo-spiral groove, where the branches to that muscle are given off. M. Ollier concluded that the nerve was compressed either by one of the fragments or by exuberant callus. Prolonged treatment directed towards the removal of the callus having failed, the patient was submitted to operation. An incision having been made in the presumed direction of the nerve, so as to expose it in the external intermuscular septum, it was found by tracing a branch upwards. A gutter was next cut with chisel and mallet for 1½ inch through the callus, this step exposing the nerve, swollen and hypertrophied in its lower part, and above, strangled (as if by a ligature) by a point of bone apparently belonging to the lower fragment. This point being cut off, and a probe passed behind the nerve to secure its complete isolation, the nerve was then followed for ¼ inch above and below the bony canal, so as to ensure its liberation, and, in order to obviate any reproduction of bone, the periosteum was removed all round. The nerve was not disturbed from its gutter, for fear of contusing or stretching it. The wound healed rapidly. From the sixth day the patient experienced some pricking sensations on the back and outer part of the forearm, and sensibility began to increase in the thumb and forefinger. On the twentieth day he could raise his hand a little by voluntary efforts; and when he left the hospital, six months and a half after the operation, he insisted on going back to his work in the fields.

Similar cases have been recorded by M. Trélat, by M. Tillaux (*Traité d'Anatomie Topographique*, p. 511), and by Mr. Puzey,† of Liverpool (*Brit. Med. Journ.*, vol. ii. 1889, p. 309), in each case with a successful result. The nerve was found either between the two heads of the triceps, or by following it up from its site between the brachialis anticus and supinator longus. In Mr. Puzey's case it had been noted, three months after the fracture, that there was rather an excess of callus present.

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* The occasional abundance of this callus may, perhaps, be in part accounted for by the great thickness of the periosteum of the humerus.

† This surgeon also relates (*Brit. Med. Journ.*, vol. i. 1885, p. 979) a case in which he successfully operated, six months after the injury, in order to set free the ulnar nerve which had been drawn into the callus uniting a compound fracture of the bones of the forearm.

Suture.—Mr. Lucas (*Guy's Hosp. Rep.*, xlvi. p. 1) records two cases of division of this nerve by stabs.

In one case, a lad aged 16, the axillary vein and superior profunda were wounded as well, the musculo-spiral nerve was divided, and its lower part torn and notched. The damaged part was cut away, and the ends united by two catgut sutures. Complete recovery followed, about three months after the injury. The other case dated to an injury about two months before. The scar was five inches from the acromion, opposite the insertion of the deltoid, rather behind the line of the humerus on the outer side. On laying bare the nerve it was found that there was a high division into radial and posterior interosseous, the latter being completely severed just after its origin. The musculo-spiral just before its division, and the radial at its commencement, were involved in dense scar tissue. They "were relieved" from this, and the ends of the posterior interosseous after resection were united by fine catgut. The arm gradually improved with three months' galvanism, and a complete cure followed.

CHAPTER VI.

OPERATIONS ON THE AXILLA AND SHOULDER.

LIGATURE OF THE AXILLARY ARTERY
(Figs. 61 to 66).

Indications.

1. Wound of the artery.* 2. Aneurysm of the brachial high up.† The following instructive case (*Lancet*, 1895, vol. i. p. 92) will repay perusal. It (1) enforces the importance of exploring at once a wound near a large artery that has bled "profusely"; (2) it proves, if this step be not taken and a traumatic aneurysm arise, how much the old operation of tying the vessel above and below the aneurysm and emptying the latter of clot is to be preferred to the Hunterian method;‡ and (3) it is an interesting instance that gangrene, which is by no means unknown in the lower limb after ligature of the external iliac (*q.v.*), may also occur in the upper extremity with its better collateral supply.

A man, æt. 30, accidentally stabbed himself in the outer aspect of the right arm, in its middle third. Profuse hæmorrhage followed. The wound was cleansed and dressed antiseptically, and the arm was bandaged from the hand upwards. The patient was sent home, but at night severe bleeding again set in. This was arrested by "plugging." The following night hæmorrhage recurred, and was again arrested by plugging. The wound gradually healed, and three weeks later a circumscribed traumatic aneurysm of the brachial artery developed at "the seat of the original wound, but on a higher level." The aneurysm increased rapidly, soon occupying the whole of the inner and anterior aspect of the upper arm, causing œdema and loss of sensation of the hand and fingers. About fourteen days later, pressure having failed, it was decided to tie the axillary artery in its third part. This cured the aneurysm, but gangrene* of the thumb, together with sloughing of the tendons of the forefinger, commenced thirty hours afterwards. Amputation of the thumb at the metacarpo-phalangeal joint was required later on, and the index finger remained stiff.

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* In some wounds of the artery, the surrounding parts—*e.g.*, veins and nerves—may be so injured, that the vitality of the limb is impaired beyond what ligature and nerve-suture can do, and the advisability of amputating at the shoulder-joint must be considered.

† Dr. Holt (*Amer. Journ. Med. Sci.*, April 1882, p. 385) mentions a case of aneurysm of the right brachial at its upper third, treated by ligature of the axillary in its lower third. Secondary hæmorrhage supervened; the axillary artery was then tied in its upper third, and a cure followed.

‡ It is always invidious to criticise cases, especially those which the writer has not seen, and it is only fair to the surgeon who publishes this case to quote his words. "The only alternative would have been to open the aneurysm, turn out the contents, and attempt to tie both ends of the artery, an operation fraught with great danger to the limb and to the patient in his then weakened condition."

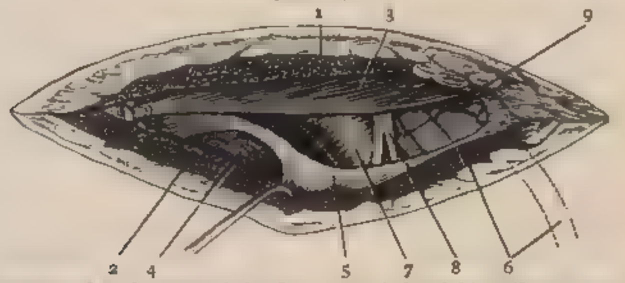
More rarely still—3. As a distal operation for aneurysm of the subclavian. 4. Very occasionally, as the old operation after rupture of the axillary artery in shoulder dislocations (p. 133). 5. Very occasionally, as the old operation for axillary aneurysm (p. 133). 6. For hæmorrhage from malignant disease in the axilla.

These last are extremely rare, but a good instance, and one showing the difficulty of meeting them, was published by Sir W. Savory (*Med.-Chir. Trans.*, vol. lxix. p. 157).

Operations.—Ligature of the first and the third parts of the artery will be first described, and then the old operation.

i. **Ligature of the First Part** (Figs. 61, 62, 63 and 65).—This operation is very rarely performed on the living subject. Owing to the depth of the vessel here, its most important and intimate surroundings, and the risk of secondary hæmorrhage from the vessels which lie so close to the knot, ligature of the third part of the subclavian is preferred if ligature be required for axillary aneurysm. On the dead subject the student should always take the opportunity of tying the first part of the axillary, as it is an excellent test of anatomical knowledge and practical skill.

Fig. 61.



Parts concerned in ligature of the first part of the (left) axillary artery: 1 and 2, Cut edges of the clavicular attachment of the pectoralis major. 3, Subclavius. 4, Axillary vein. 5, Sheath of subclavius, which, depressed, has partly concealed 6 (the cephalic vein), seen to the right. 7, Axillary artery. 8, Nerve to pectoralis major. 9, Cords of brachial plexus. (Farabeuf.)

Line.—From the centre of the clavicle (with the arm drawn from the side) to the inner margin of the coraco-brachialis.

Guide.—The above line, and the inner margin of the coraco-brachialis.

Relations:— In Front.

Skin; fasciæ; fibres of platysma. Supra-clavicular nerve.
Pectoralis major (with muscular branches).
Costo-coracoid membrane.
Cephalic vein. Acromio-thoracic vessels.

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* In this case the repeated bleeding had reduced the size of the main vessel (as in the case mentioned at p. 117) and its anastomoses. Ligature of the axillary artery, very probably, further cut off the blood supply through one of the most important collaterals—viz., the superior profunda (p. 115).

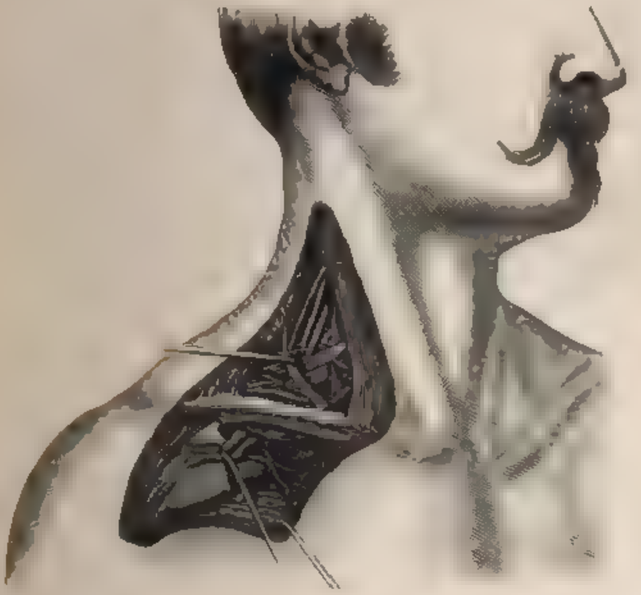
OUTSIDE.		INSIDE.
Outer and inner cords of brachial plexus.	Axillary artery, first part.	Axillary vein.

BEHIND.
First digitation of serratus magnus.
First intercostal space and muscle.
Posterior thoracic nerve.

Collateral Circulation (Fig. 57):

(*a*) If the artery be tied in its first part, and the ligature be placed above the acromio-thoracic, the vessels concerned will be the same as those which carry on the blood-supply after ligature of the third part of the subclavian (*q.v.*).

FIG. 62



Relations of subclavian and axillary arteries The sterno-mastoid, trapezius, and omo-hyoid are seen above The blunt hook draws outwards the external jugular, which is falling into the subclavian vein The artery is seen emerging from beneath the scalenus anticus, below the nerves Two arterial branches pass outwards—the one close to the clavicle, the supra scapular, the other, higher up, the posterior scapular, or transverse cervical Below are seen the deltoid, the subclavian, a blunt hook depressing the clavicular part of the pectoralis major, the coracoid process, the lesser pectoral, and the lower part of the costo-coracoid membrane Another hook depresses the cephalic vein, and exposes the artery, which here gives off its acromio-thoracic branch (Farabeuf)

(*b*) If the artery be tied in its third part, and the ligature be placed below the circumflex arteries, the anastomosing vessels will be the same as after ligature of the brachial above the superior profunda (p. 115).

(*c*) If the artery be tied in its third part, and the ligature be placed between the subscapular and circumflex arteries, the chief vessels concerned are:

ABOVE.		BELOW.
The supra-scapular The acromio-thoracic	with	The posterior circumflex.

(*d*) If in tying the third part of the artery the ligature be placed above the subscapular, the anastomoses are more numerous—viz., in addition to those just given:

ABOVE.		BELOW.
The supra-scapular The posterior scapular	with	The subscapular.

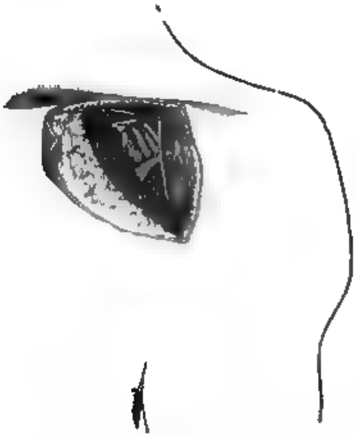
Operation.—The vessel may be secured in the following ways. The first two are recommended.

A. By a curved incision below the clavicle.—This gives the necessary room, but has the disadvantage of dividing the pectoralis major and its large muscular branches.

B. By an incision in the interval between the pectoralis major and deltoid (Fig. 63).—This method scarcely gives sufficient room, especially if the parts are displaced by effused blood, &c., and it is well to supplement the incision in the interval by one partly detaching the pectoralis from the clavicle (p. 131). While this plan involves less hæmorrhage from the pectoralis major, care must be taken to avoid the cephalic vein and acromio-thoracic branches which lie in this interval. This end is best secured, whichever method be adopted, by going down on the artery as close to the clavicle as possible, the sheath of the subclavius being opened, and some of its fibres detached, if needful.

C. By an incision in the line of the artery, viz., one 3½–4 inches long, starting from just outside the centre of the clavicle, and passing downwards and outwards.—This has the disadvantage of cutting the muscular branches to the pectoralis major, and gives less space than the first two.

FIG. 63.



Part of the clavicular origin of the pectoralis major has been turned inwards with the flap of skin. The costo-coracoid membrane is seen cut above and below the artery, in the latter case being turned down over the pectoralis minor.

The cephalic vein runs up along the inner edge of the deltoid; a second vein lies on the cords of the brachial plexus above the artery, while others cross the upper part of the wound. A small portion of the artery has been cleaned.

A. The limb being at first abducted, the surgeon, standing between it and the body, which is brought to the edge of the table, makes a curved incision, with its convexity downwards and about ½ inch from the clavicle, reaching from just outside the sterno-clavicular joint to the coracoid process, the knife being used lightly at the outer end of the incision, so as to avoid wounding the cephalic vein and branches of the acromio-thoracic vessels. The clavicular origin of the pectoralis major is then divided in the whole extent of the wound, and any muscular branches which require it tied or twisted at once. The cellular tissue beneath the muscle being next explored with the tip of the finger and director, the upper border of the pectoralis minor is defined, and this muscle drawn downwards. The costo-coracoid membrane must next be most carefully torn through close to the coracoid process, which is a good guide, by means of a fine-pointed steel director, the cephalic vein and acromio-thoracic vessels being most scrupulously avoided. The wound all this time must be kept dry, and, if needful, a large laryngeal mirror or an electric lamp may be usefully employed in throwing light into the bottom of the deep wound. The pulsation of the artery being felt for in the living, and its flattened cord-like feel made out in the dead subject, the sheath is exposed,[*] and the vessel itself carefully cleaned and separated from the vein, which lies below and in front, and from the brachial cords, which are above the artery. The needle should be passed from below so as to avoid the vein.[†]

B. By an incision made between the pectoralis major and deltoid (Fig. 63). The limb and the surgeon being in the same position as in the operation just given, an incision is made obliquely downwards and outwards between the above muscles, commencing at the clavicle opposite to the coracoid process. Care being taken to avoid the cephalic vein and branches of the acromio-thoracic vessels, the muscles are separated, and, to gain more room,[‡] a transverse incision is made running inwards along the lower border of the clavicle, and detaching as much as is required of the clavicular origin of the pectoralis major. This flap can be turned inwards and downwards without any interference with the nerve-supply of the muscle, and, owing to its division high up, less hæmorrhage is met with by this method. The deltoid being strongly drawn outwards with a retractor, the upper border of the pectoralis minor is defined, and the operation completed as in the account already given, the parts being relaxed at this stage by adduction of the arm.

ii. **Ligature of the Third Part of the Axillary Artery** (Fig. 64).

LINE.—From the centre of the clavicle, with the arm drawn from the side, to the inner margin of the coraco-brachialis.

GUIDE.—1. The above line. 2. A line drawn from the junction of the middle and anterior thirds of the axilla, along the inner border of the coraco-brachialis (Fig. 64).

RELATIONS :—

IN FRONT.
Skin ; fasciæ.
Pectoralis major (at first).

OUTSIDE.		INSIDE.
Musculo-cutaneous, median. Inner border of coraco-brachialis.	Axillary artery, third part.	Internal cutaneous ; ulnar. Axillary vein or venæ comites.

BEHIND.
Subscapularis. Latissimus dorsi. Teres major.
Circumflex nerve. Musculo-spiral.

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[*] The parts may now be advantageously relaxed by adducting the arm.

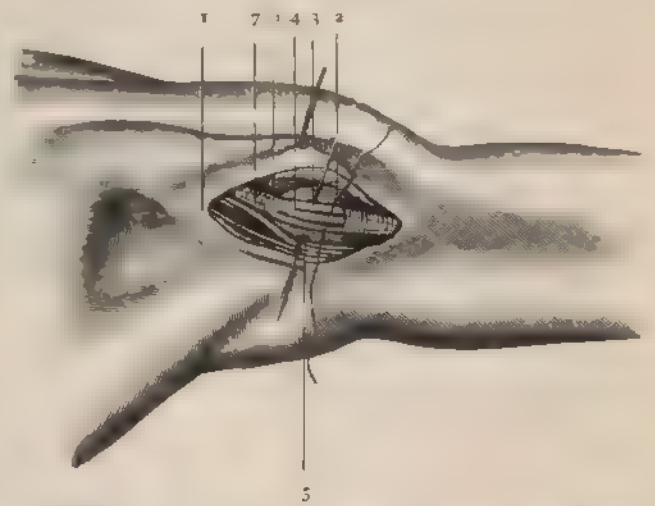
[†] The patient must be prepared for probably weakened or limited use of the limb for some time, at least, after the main arterial trunk has been ligatured.

[‡] This step was advocated by Mr. Rivington (*Brit. Med. Journ.*, 1885, vol. i. p. 1040).

Operation (Fig. 64).—This resembles somewhat that for ligature of the brachial in the middle of the arm. As with the brachial, so with the axillary here; though the vessel is comparatively superficial, it is not an easy one to hit off at once, owing to the numerous surrounding nerves, which may resemble the artery closely, especially if blood-stained.

The axilla having been shaved and thoroughly cleansed (p. 99), the arm being extended from the side and rotated slightly outwards (not too forcibly, as this will alter the relations), the surgeon, sitting between the limb and the trunk, makes an incision 3 inches long, at the junction of the anterior and middle thirds of the space along the inner border of the coraco-brachialis (Fig. 64). The incision may be begun above or below, as is most convenient. Skin and fasciæ being divided, and the point of a director used more deeply, the coraco-brachialis is identified, and the axillary vein and the median nerve are distinguished from the artery, the former drawn inwards, and the latter, together with the coraco-brachialis, outwards.* The artery is then made sure of, cleaned and the needle passed from within outwards, the neighbourhood of any large branch, such as the subscapular or the circumflex, being avoided.

FIG. 64.



Ligature of third part of (left) axillary artery. 1, Axilla at the junction of its middle and anterior thirds. 2, Coraco brachialis, and above it biceps. 3, Median nerve. 4, Axillary artery. 5, Axillary vein. 6, Internal cutaneous nerve. 7, Ulnar nerve hooked downwards.

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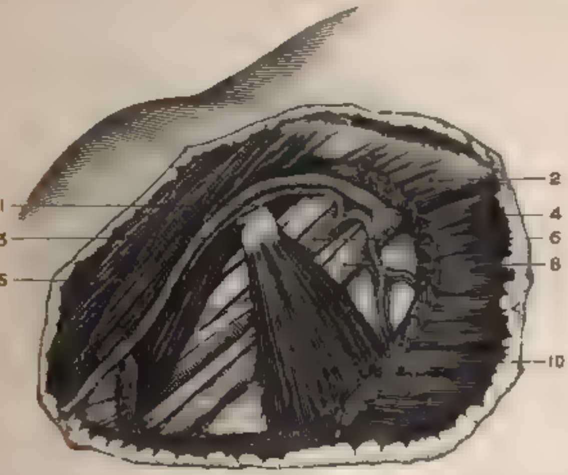
* Farabeuf (*loc. supra cit.*, p. 44) gives the following directions for making sure of the artery: Make an incision running just behind the anterior wall of the axilla. Identify the coraco-brachialis by opening its sheath. Draw it outwards, and, with the finger of the left hand sunk in the wound, depress the whole bundle of vessels and nerves. The first cord which escapes upwards, when the finger is withdrawn a little, is free, perforating no muscles: this is the median. Isolate it and have it drawn outwards with the coraco-brachialis. The second large cord, uncovered by withdrawing the first, is the artery.

and the needle being kept very close to the artery. Instead of one axillary vein, two venæ comites, and the basilic as well, may be present.

iii. **Old Operation of Ligature of the Axillary Artery for some Cases of Axillary Aneurysm and Injured Axillary Artery.**—This method may be made use of in the following instances:

1. Where pressure has failed in the above cases. 2. Where pressure is unsuitable owing to the rapid increase, and large size, of the aneurysm; the condition of the parts over it; or the inability of the patient to bear pain. 3. Where, owing to the displacement of the clavicle, ligature of the subclavian is not likely to be practicable, or where the condition of the coverings of the aneurysm is such that this step, even if carried out, will not avert suppuration, sloughing, &c.

Fig. 65.



Anatomy of the parts concerned in ligature of the axillary artery (Heath.) 1, The outer head of the median, and, external to it, the musculo-cutaneous nerve. Internal to the artery is the inner head of the median, which crosses it below the pectoralis minor, 10. Internal to the artery at this level are the internal cutaneous and the ulnar nerves. 2, Pectoralis major. 3, Cephalic vein. 4, Humeral and pectoral branches of the acromio-thoracic artery. 5, Deltoid. Under this is seen part of the coraco-brachialis and biceps. 6, Axillary artery. 8, Axillary vein.

Prof. Syme (*Observations in Clinical Surgery*, p. 140 *et seq.*), holding that the old method would certainly remedy cases not amenable to ligature of the subclavian, and that even in cases where the latter is practicable the former might be preferable, made use of it in three cases.

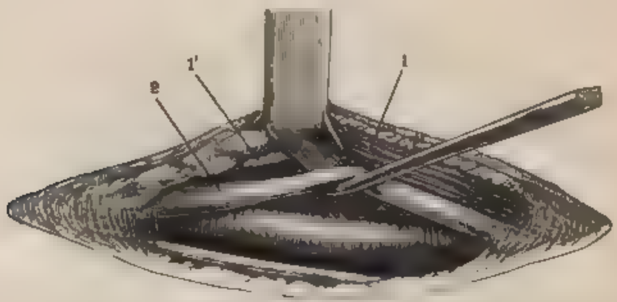
In the first case, the skin in the neighbourhood of the shoulder-joint was dusky red and vesicating, and the patient beginning to wander in his mind. In the third, after the operation delirium tremens set in, with excessive suppuration and sloughing of the tissues of the limb. All three patients recovered, though in age 50, 47, and about 50 respectively.

The following is the account of the operation in Prof. Syme's words (*loc. supra cit.*, p. 148):

I made an incision along the outer edge of the sterno-mastoid through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian lies upon the first rib. I then opened the tumour,* when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly seven pounds of coagulated blood. The axillary artery appeared to have been torn across, and, as the lower orifice still bled freely, I tied it in the first instance, next cut through the lesser pectoral muscle close up to the clavicle, and, holding the upper end of the vessel between my finger and thumb, passed an aneurysm-needle so as to apply a ligature about ½ inch above the orifice. The extreme elevation of the clavicle, which rendered the artery so inaccessible from above, of course facilitated this procedure from below. Everything went on favourably afterwards.

Sir J. Paget and Mr. Callender (*St. Bartholomew's Hosp. Rep.*, vol. ii.) made a ⊣-shaped incision, cutting parallel with the lower margin of the pectoralis major, and a second, at right angles to the first, straight up through the whole width of the pectoralis major.

FIG. 66.



Parts seen in ligature of the third part of the (left) axillary artery, dissected. The flat retractor raises (1) the coraco-brachialis, the first guide, together with (1') the musculo-cutaneous nerve entering it. The blunt hook draws aside (2) the median nerve, the second guide. Below the axillary artery is seen the small internal cutaneous nerve, which, like the axillary vein and the other large nerve trunks, is often not seen. Just above the artery, in the depth of the wound, is seen one of the venæ comites. (Farabeuf.)

The following case under the care of Dr. N. Raw, of Liverpool (*Liverpool Med.-Chir. Journ.*, July 1899, p. 328), teaches a point which may be most valuable in the treatment of these rare but very grave cases—viz., putting *a temporary* ligature round the axillary artery until it is certain whether both this and the vein have given way.

The patient was aged 45, and, five weeks after a dislocation of the humerus had been reduced, a surgeon had manipulated the arm with his heel in the axilla. The arm began to swell the same night. There was slight pulsation in both radial and ulnar arteries. As the accumulation of symptoms had been gradual, rupture of the axillary vein was diagnosed. The swelling increased, and burst with serious loss of blood. An incision was made from the clavicle to the anterior fold of the axilla, dividing the pectoral muscles. The axillary vessels were ligatured under the clavicle, the artery with a temporary ligature. The incision was then prolonged through to the axilla, down the inner side of the arm to the elbow, and several pounds of clot turned out. The axillary vein was found torn completely across, and was tied at both ends; arterial blood was seen to be flowing, and the subscapular artery was found cut across about one inch from the main trunk, and tied. The temporary ligature was then removed from the first part of the axillary artery, and followed by redness and warmth in the limb, but no pulsation in the radial artery. The patient made an excellent recovery, and six months later had a fairly useful limb.

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* In one of his cases, while laying open the cavity, Prof. Syme had to avoid the radial artery, which ran over the surface of the sac.

A short space may be allotted here to that most important accident which has happened to so many surgeons—viz., **rupture of the axillary artery while dislocations of the shoulder are being reduced.** This accident has greatly decreased in frequency of late years owing to the advantages of anæsthetics and the earlier date at which patients apply for treatment. Dr. Stimson (*Ann. of Surg.*, Nov. 1885) draws the following conclusions from forty-four cases, conclusions which modern surgery and an earlier resort to the use of the double ligature may considerably modify:—"Conservative treatment—viz., complete rest with direct pressure—may properly be tried at first, especially if the tumour is small, recent, and not increasing, but should not be prolonged if the symptoms do not promptly yield; and secondly, in case of resort to operation, ligature of the subclavian or disarticulation at the shoulder is to be preferred to incision of the sac and double ligature of the artery." Of seven cases of double ligature of the artery, all were fatal. Of fourteen of ligature of the subclavian, five recovered. Without operation, thirteen died, six recovered. Of four cases of amputation at the shoulder, only one recovered. Repeated puncture is always fatal. Körte, of Berlin (*Arch. f. klin. Chir.*, Bd. xxvii. Hft. 3, quoted by Dr. Stimson), is of opinion that in many cases the injury to the artery is caused at the time of the accident, but hæmorrhage does not come on till after reduction is brought about, as the vessel is compressed by the head of the bone. As to the exact cause of the injury to the vessel when it takes place at the time of the reduction, it is probable that some special condition exists to account for it, as many old dislocations are reduced with much force, used with impunity—*e.g.*, atheroma; adhesion of the artery to the head of the bone; too great or misapplied force in reduction, viz., use of the boot, in elevation; projection of a fragment or a spicule of bone. It is usually the axillary artery, or one of its branches, which gives way; much more rarely (four out of forty-four cases), the axillary vein.

AMPUTATION AT THE SHOULDER-JOINT.

Indications.

i. Compound comminuted fractures—*e.g.*, railway and machinery accidents.

ii. Gunshot injuries.—Amputation here is divided by Dr. Otis* into (1) Primary, or before the third day; (2) Intermediary, or cases in which the operation was performed between the third and the thirtieth days; and (3) Secondary, in which the operation was performed later than the thirtieth day.

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* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 613 *et seq.*

(1) Primary.—The mortality here was 24 per cent. The indications for amputation so soon after the injury are chiefly—(*a*) A limb torn off partially, but too high to admit of any other amputation; (*b*) Severe comminuted fracture of the upper end of the humerus, with extensive injury to the vessels and nerves; (*c*) Such a fracture high up, with severe splintering extending down below the insertions of the pectoralis major and the latissimus dorsi.* (2) Intermediary.—The mortality here, 45 per cent., was nearly double that of the primary. This seems to have been brought about largely by the fact that the operation was now performed through soft parts, the seat, at this time, of unhealthy inflammation, and thus prone to lead to secondary hæmorrhage, pyæmia, sloughing, &c. (3) Secondary.—The causes for this deferred operation were chiefly hæmorrhage, gangrene, profuse suppuration, hopeless disease of the humerus, sometimes with consecutive implication of the joint, chronic osteo-myelitis, or necrosis of the entire humerus. The mortality was 28 per cent. From the above it is evident that the necessary examination should be made, and the operation performed, as soon after the injury as possible, consistent with the state of the patient; the difference between operating in sound and diseased parts, and the neighbourhood of the joint to the chest, if a septic condition of the wound sets in, being borne in mind.

iii. New growths.—If these involve the scapula or its processes, the upper extremity should be removed by the method of interscapulo-thoracic amputation (p. 177). The question of the possibility of saving the limb and removing the growth by excision of the head of the humerus is considered at p. 157.

iv. Disease of the shoulder-joint unsuited for, or persisting after failure of, excision.

v. For osteo-myelitis and necrosis of humerus resisting other treatment, or complicated with early blood-poisoning.

vi. For rapidly spreading gangrene or gangrenous cellulitis with threatening septicæmia.

Mr. Heath (*Clin. Soc. Trans.*, vol. xiv. p. 114) has recorded such a case in which this amputation was needed to save life.

A nurse had pricked her finger deeply with a pin hidden in some of the clothes of a lady who had died of virulent puerperal septicæmia; gangrenous cellulitis rapidly set in, and extended in spite of incisions: on the sixth day the gangrene appeared to be arrested in the forearm, though there was a blush of advancing mischief up the arm. In the afternoon of the same day sudden extension took place, and Mr. Heath removed the arm at the shoulder-joint, the patient ultimately making a good recovery.

The operation chosen was by outer and inner flaps, the former giving a fairly healthy flap of deltoid, the latter having to be cut very short owing to the infiltration of the axilla. The dressings became offensive, but the stump healed well.

vii. For removal of the upper extremity where painful, œdematous, and heavy owing to pressure on the axillary veins and brachial plexus by recurrent carcinoma. Here removal of the whole upper extremity by M. P. Berger's method (p. 177) is much to be preferred.

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* In some of these the adoption of the Furneaux Jordan method (p. 149) might lead to diminished loss of blood.

viii. Amputation at the shoulder-joint may be called for in the following cases of aneurysm :—

A. In *some cases of subclavian aneurysm* where other means have failed or are impracticable; where the aneurysm is rapidly increasing; where the pain is constant and agonising; and where the limb is threatening to become gangrenous. While the principle of this operation appears to be physiologically sound—*i.e.*, to enable distal ligature to be performed on the face of the stump, and that, by removal of the limb, the amount of blood passing through the aneurysm may be diminished—the results hitherto have not been very successful.

Thus, in Prof. Spence's case (*Med.-Chir. Trans.*, vol. lii. p. 306), a man, aged 33, with a subclavian aneurysm, probably encroaching on the second, if not the first, part of the artery, with excruciating pain and threatening gangrene, amputation at the shoulder-joint was followed by diminution in the pulsation and size of the sac, but with little formation of coagula. Death took place four years afterwards, probably from extension of the aneurysm to the innominate and aorta. In this case the operation, though it had but little effect in consolidating the sac, undoubtedly prolonged life, as gangrene was threatening, and the second part of the artery was almost certainly affected, thus rendering the case a most unfavourable one. In Mr. Holden's (*St. Barthol. Hosp. Rep.*, vol. xiii.) case the patient was almost *in extremis*, and the sac gave way. In Mr. H. Smith's case (quoted by Mr. Heath, *loc. infra cit.*) an intrathoracic portion of the aneurysm also ruptured, there being no evidence as to benefit or otherwise.

In Mr. Heath's* case (the aneurysm being perhaps traumatic in origin, and of the false circumscribed kind) the effect on the aneurysm was so transient as to be practically *nil*. Two months after the amputation, as the aneurysm continued to increase in size, Mr. Heath introduced into the sac three pairs of fine sewing-needles, making each pair cross within the sac. Considerable clotting took place around the needles, which were withdrawn on the fifth day. The aneurysm gradually became solid, but the patient sank soon after from bronchitis. Mr. Heath concluded that amputation at the shoulder-joint for aneurysm is not a satisfactory proceeding, but the majority of the surgeons present were in favour of further trials of this mode of treatment if it could be resorted to early.

B. With the same objects in view, amputation at the shoulder-joint may be required in *some cases of axillary aneurysm* complicated with extension of the sac upwards, much elevation of the shoulder, conditions which may render compression or ligature of the subclavian impossible, removal of the limb being additionally called for if agonising pain or threatening gangrene be present.

Prof. Syme (*Med.-Chir. Trans.*, vol. xliii. p. 139) briefly alludes to two such successful cases, in one of which gangrene was threatening: "In a case of axillary aneurysm in a gentleman of about 52 years of age, where ligature was prevented by intense inflammation of the arm, rapidly running on to gangrene, I performed amputation at the shoulder-joint, cutting through the sloughy sides of the aneurysm and tying the artery where it lay within the sac."

C. In *some cases of inflamed axillary aneurysm* threatening suppuration, Sir J. E. Erichsen (*Surg.*, vol. ii. p. 217) points out that the question of this amputation may arise. As the old operation of opening the sac, turning out the clots, and securing the vessel above and below is impossible, owing to the fact that the coats of the vessel, now softened, will not hold a ligature, two courses only are open to the surgeon—viz., ligature of the third part of the subclavian, or amputation at the shoulder-joint. While the former may be followed when the aneurysm is moderate in size and when there is no evidence of threatening gangrene, amputation must be resorted to when less favourable conditions are present.

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* In a paper brought before the Medico-Chirurgical Society (*Trans.*, vol. lxiii. p. 65). For [illegible] on this, see *Lancet*, 1880, vol. i. p. 169; *Brit. Med. Journ.*, 1880, vol. i. p. [illegible]

If hæmorrhage occur from an inflamed axillary aneurysm which has ruptured after the subclavian has been already tied, the same writer, of the two courses now open—viz., either to open the sac and try and include the bleeding spot between two ligatures, or to amputate at the shoulder-joint—strongly advises the latter.

The coats of the artery "in the immediate vicinity of the sac could not, in accordance with what we know to be almost universally the case in spontaneous aneurysms of large size or old standing, be expected to be in anything like a sound, firm state, and would almost certainly give way under pressure of the noose; or the vessel might have undergone fusiform dilatation, as is common in this situation, before giving rise to the circumscribed false aneurysm, in which case it would be impossible to surround it by a ligature; or, again, the subscapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these the danger of the patient would be considerably increased by the irritation and inflammation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurysm, and much valuable time would be lost in what must be a fruitless operation, at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus to remove the whole disease at once."

D. In the words of Sir J. E. Erichsen (*loc. supra cit.*, p. 218), "there is another form of axillary aneurysm that requires immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not; it is the case of *diffuse aneurysm of the armpit*, with threatened or actual gangrene of the limb."

Different Methods.—Of some thirty-six different methods which have been described, most will be found to differ in some unimportant detail. Five alone will be given here; they will be found amply sufficient, if modified when needful, for all cases. The circumstances under which this amputation is performed do not admit of any one definite method being followed. Thus, after a railway accident or gunshot injury, the soft parts will be destroyed on at least one surface. In amputating for malignant disease, skin flaps must be made use of, transfixion being usually inadmissible, as the muscles should be cut as short and as close as possible to their upper attachments, to minimise the risk of extension and recurrence. Instead of remembering the length and size of differently named flaps, the surgeon will have to be familiar with the anatomy of the parts, the position of the vessels, and the best means of meeting hæmorrhage.

The joint is so well covered that sufficient flaps* can nearly always be provided, while the blood-supply is so abundant that sloughing very rarely occurs, and even if it do so, from the results of injury or hospital gangrene, the tissues of the chest will come forward sufficiently to close the wound. While the cavity of the axilla favours exit of discharges below, the abundance of cellular tissue opened up favours diffuse inflammation, and calls for adequate drainage.†

The following methods will be described here: in the first two, skin flaps are made; in the others (save in the Furneaux Jordan method), transfixion is made use of, in part at least.

In all cases of doubt, as after injury, the condition of the bone, and, if needful, that of the vessels and nerves, should be first cleared up by a free incision as if for excision (Figs. 70, 71 and 73, pp. 142, 143).

i. By lateral skin flaps. The oval or *en raquette* methods.
ii. Spence's method.
iii. Superior and inferior flaps.
iv. Superior or deltoid flap.
v. Anterior and posterior flaps.
vi. Furneaux Jordan method.

While the most rapid methods are those of superior and inferior (Figs. 76 and 77), or anterior and posterior flaps (Fig. 78), in each case cut by transfixion, these require the presence of an assistant who can be thoroughly relied upon to seize the artery just before it is cut. Where there is time, and where the soft parts admit of it, one of the methods with a vertical incision—*e.g.*, Spence's method, the *en raquette*, or that by lateral skin flaps—is far preferable, as (1) it allows of securing the artery before this is cut; (2) of exploring the condition of the head of the bone; (3) one flap can be cut longer, according to the state of the soft parts.

Means of arresting Hæmorrhage in Amputation at the Shoulder-joint.—These are numerous. The first is the best.

1. LIGATURING OR TWISTING THE VESSELS ON THE INNER ASPECT OF THE LIMB BEFORE THEY ARE CUT (pp. 141, 146, Figs. 69, 72).

This method is an excellent one and suitable to all cases. The ligature should be placed as high as possible, so as to get above the circumflex arteries. The surgeon must be careful in the final use of the knife, high up in the axilla, not to prick the artery above his ligature.

2. COMPRESSION OF THE INFERIOR OR ANTERIOR FLAP, AND SO OF THE VESSELS BEFORE THEY ARE CUT (pp. 148, 149, Figs. 76, 77).

3. PRESSURE ON THE SUBCLAVIAN.—I am of opinion that the more the surgeon trusts to this plan solely, the more often will he have cause to regret it. Pressure is always liable to be inefficient in short, fat necks; in thin patients, however well applied at first with the thumb aided by a padded key or weight, it is too often rendered uncertain by the necessary changes in position of the limb during the operation, or by the pressure of assistants, a violent gush of blood at the last showing to the surgeon that his confidence in the artery being secured is misplaced. Furthermore, an assistant so used is necessarily much in the way of the

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* In some cases of gunshot injury it is necessary to get the chief flap from the axillary region, and to bring this up and unite it to the cut margin of skin over the acromion.

† Finally the tendency of the skin to retract when this has been much stretched, as over a large tumour, should be remembered.

others aiding the surgeon. For the above reasons I much prefer trusting to one or other of the two methods first given.

4. LIGATURE OF THE SUBCLAVIAN ARTERY.—Mr. Howard Marsh successfully made use of this method in a case of amputation for an enormous "osteo-sarcoma" of the humerus.

After ligature of the third part of the subclavian, it was easy to empty back into the general circulation the blood out of the enormous vein which ran over the surface of the growth. Eight ounces of blood was the amount estimated to have been lost.

5. LIGATURE OF THE FIRST PART OF THE AXILLARY ARTERY.—This step, originally recommended by Delpech, has been recently advocated by Prof. Keen (*Amer. Journ. Med. Sci.*, June 1894) in those cases where a growth has invaded the axilla high up. Thus, a free incision between the pectoralis major and deltoid (p. 130) will at once give us access to the apex of the axilla, where the vessels lie, and enable us to determine how far the growth has extended.

6. WYETH'S METHOD BY PINS AND ELASTIC TUBING.—I mention this method here out of respect to the inventor and the American surgeons who have used it. I do not recommend it, for these reasons: It is clear from a paper by Prof. Keen, of Philadelphia (*Amer. Journ. Med. Sci.*, 1894), that unless the pins are inserted very exactly—not an easy matter in operations of emergency—the tubing may slip, even when applied by this method. I consider the practice of finding the vessels and securing them before they are severed a great deal simpler and applicable to all cases. Finally, I cannot but think that, when a larger number of cases have been published in which the pins have been made use of, it will be found that the passage of long pins, even when sterilised, is not always "absolutely of no importance." Prof. Keen thus describes the method, which he used successfully in two cases, and which he thinks superior to every other:

Two sharp-pointed pins, 11 inches long and of No. 20 French catheter size, are used. As much force is required to push the pins through the tissues, it is advised that the points should be made trocar-like. The anterior pin is introduced through the middle of the anterior axillary fold, at a point a little nearer to the body than what may be called the centre of the fold transversely. The point of emergence is of much greater importance, and should be an inch within the tip of the acromion. The second pin is inserted at a corresponding point through the posterior axillary fold, emerging again an inch within the tip of the acromion. Some care is needed to avoid striking the spine of the scapula. The pins being in position, a piece of black india-rubber tubing, half an inch in diameter, is bound tightly round the axilla and shoulder above the pins.

The method will be found described and illustrated under the section dealing with "Amputation at the Hip-joint."

7. SECURING THE VESSELS LOWER DOWN, IN THE FURNEAUX JORDAN METHOD (p. 149).

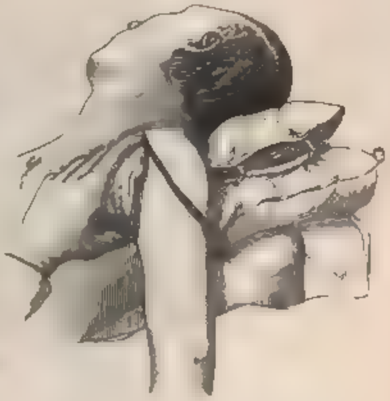
8. USE OF AN INDIA-RUBBER BAND.—This is applied after the same method as that fully given in "Amputation at the Hip-joint." In my opinion it is unreliable, especially in those cases of accident in which, the limb being mutilated high up, this operation is chiefly required. For in these the band, being applied under the axilla and across the

body, slips up as soon as the head is disarticulated, allowing of bleeding from the vessels, and coming, itself, most inconveniently, and a source of sepsis, into the way of the operator.

1. **Lateral Flaps—Oval—En Raquette** (Figs. 67 to 73).—The method of lateral flaps, or the above modifications of it, or Spence's method, are those which the student is especially recommended to practise, on account of the advantages already given.

The methods of arresting the hæmorrhage are given above. The patient having been propped up sufficiently, brought to the edge of the table, and rolled over to the opposite side, the surgeon,[*] standing outside the abducted limb on the right side, and inside it on the left, and having marked with his left forefinger and thumb a point just below and outside the coracoid process, and a corresponding point behind in the mid-axilla (Fig. 67), then reaches over, and, entering the knife in the axilla, close to the thumb, cuts an oval flap, about 4 inches long, consisting of skin and fascia from the side farthest from him, and ending close to his finger. Without removing the knife, the surgeon next marks out a similar flap on the other side, cutting from above downwards, commencing just below the finger, and ending where the first flap began in the mid-axilla. The assistant in charge of the limb aids the above by rotating the limb into convenient position. The flaps are then dissected up and held out of the way. The vessels are next exposed (see p. 132) separated from the surrounding nerves, and secured, either by applying two pairs of Spencer Wells's forceps (Fig. 69), dividing the vessel between them and twisting both ends, or by passing an aneurysm-needle, loaded with sterilised silk or chromic gut, under the artery, and thus securing it with a ligature. The limb being then carried across the chest, the outer part of the capsule is freely opened by cutting on the head of the bone, and the muscles attached to the great tuberosity thoroughly severed. The limb is next rotated outwards, and the subscapularis tendon severed; the biceps tendon being cut and the capsule freely opened, the joint is well opened on the inner side. The head being then dislocated,[†] by the assistant pressing the elbow forwards and against the side, the knife is

FIG. 67



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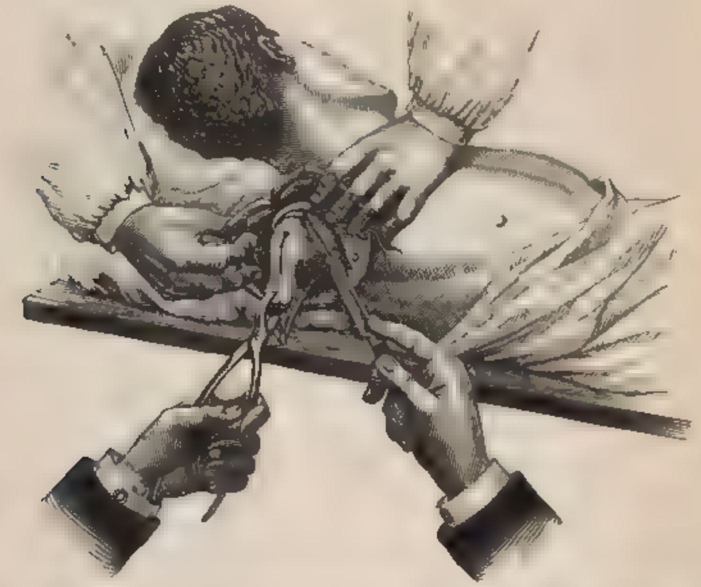
[*] Three assistants are required—No. 1, to manipulate the limb; No. 2, to grasp the artery in the inner or inferior flap, if desired; No. 3, to be ready with sponges or instruments. If the subclavian is to be controlled, this must be done by a fourth. If short-handed, the surgeon will manipulate the limb himself.

[†] This will only be feasible if the capsule has been deliberately and thoroughly opened. In any case where the leverage of the humerus is wanting, owing to this bone being broken higher up, the use of lion-forceps (Fig. 68) will facilitate disarticulation; or the surgeon will follow the expedient of Prof. Syme, quoted by Lord Lister (*Syst. of Surg.*, vol. ii., p. 712), and introduce his finger into a wound in the capsule, for the purpose of drawing down the head of the bone so as to gain access to its attachments.

passed from the outer side behind the dislocated head, and, being kept close to the inner side of the bone, is brought out through the structures on the inner aspect of the arm, care being taken, as the knife cuts its way out, that it does so below the point where the large vessels have been secured.

Method en Raquette with Preliminary Exploration (Farabeuf) (Figs. 70 to 73). —The point of the knife having been sunk just below and in front of the tip of the acromion, an incision is made downwards, sufficiently long and deep to admit of exposing the head of the humerus. If amputation is decided on, the above is converted into one *en raquette* by making an oblique incision which passes from about the centre of the longitudinal one (Figs. 70 and 71) across the inner or the outer aspect of the limb (according as it is right or left), and ends behind on a level with the lower extremity of the longitudinal one. A second exactly symmetrical to the first is next made over the opposite aspect of the limb, beginning where the first ended, and terminating in the longitudinal incision opposite to the first (Fig. 70). The next step is the exposure of the artery by division of the muscles. In the curved inner incision (Fig. 71) are seen the anterior fibres of the deltoid almost blended with the insertion of the great pectoral. This is raised with the finger, and the insertion of the great pectoral detached from the bone. If now the inner flap be folded inwards, the coraco-bicipital fasciculus comes into view. The aponeurosis over it being opened by a free longitudinal incision, the muscular fasciculus is drawn over the

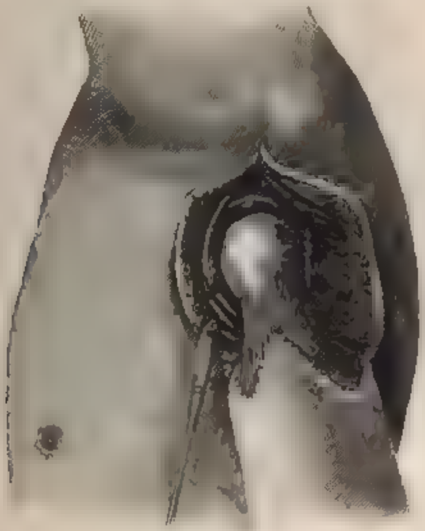
Fig. 68.



Disarticulation at the shoulder joint, the humerus being fractured high up. The operator with his left hand twists the humerus outwards, while, with his right, he divides the capsule and insertion of the subscapularis. (Farabeuf.)

front of the humerus and cut across. If an assistant now thoroughly retract the inner flap, the axillary vessels and nerves are exposed. The artery should be isolated and tied as high up as possible, so as to get above the posterior circumflex. The knife being again inserted into the outer oblique incision, the deltoid is boldly cut through as far as the back of the axilla. An assistant next retracts the outer and inner flaps, while the surgeon opens the capsule freely, the limb being rotated as directed (p. 141). The head is next thrown out of the socket, and the knife is carried behind the head, skirting the postero-internal aspect of the humerus very closely, so as not to cut the secured artery, and finally brought out through the incision on the inner side, severing the latissimus dorsi and teres major. If the artery has not been tied, an assistant secures it between his thumb, sunk deeply into the wound, and his fingers, which are in the axilla, or by using both hands.

Fig. 69.



Amputation at the shoulder-joint by lateral flaps. These are turned aside, while the axillary artery is secured by torsion before disarticulation is completed.

ii. **Spence's Method** (Fig. 75).—This excellent modification of the oval method is one with which the young hospital surgeon should be familiar owing to the facility with which the vessels can be secured and hæmorrhage met—a point of much importance in cases of accident, and when, as at night time, the operator may be short-handed. For this reason I consider it first in value. It is further especially suited to cases of failed excision,* or to cases of injury—*e.g.*, gunshot—where the surgeon has to cut into and explore the condition of the joint before deciding on excision or amputation. By its means an excision can readily be converted into a disarticulation, if this step be found needful. It admits other advantages, but less important ones:

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* At the present day, in cases of failed excision, the surgeon will often prefer to make use of the modification of the Furneaux Jordan method (p. 149).

1. The posterior circumflex artery is not divided, except in its small terminal branches in front, whereas, both in the large deltoid flap and the double flap methods, the trunk of the vessel is divided in the early steps of the operation, and, retracting, often gives rise to embarrassing haemorrhage. 2. The great ease with which disarticulation can be accomplished. 3. The better shape of the stump. Prof. Spence pointed out that, however excellent are the results soon after other methods, later on the shape of the stump is much altered, not merely from the atrophy common to all stumps, but from retraction of the muscular elements of the flaps, the pectoralis major retracting towards the sternum, and the latissimus dorsi and teres major towards the spine and scapula. Thus a deep, ugly hollow results under the acromion.

Fig. 70.

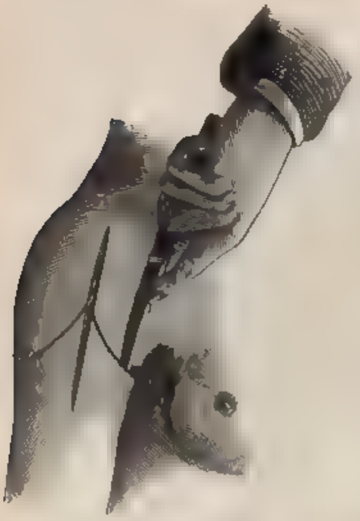
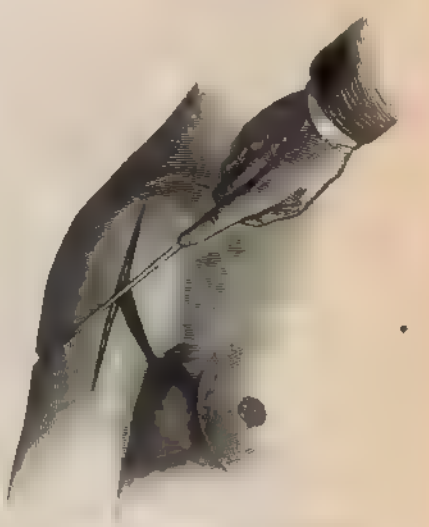


Fig. 71.

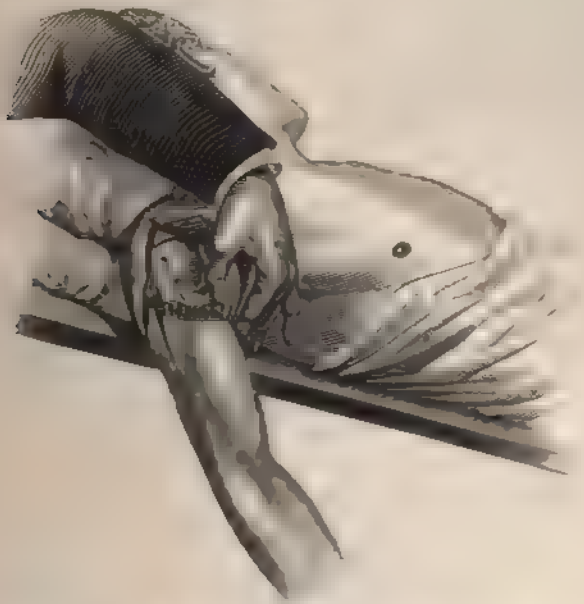


Amputation at the right shoulder-joint by the method *en raquette*. The knife is tracing the flaps, after a free exploratory incision has been made. (Farabeuf.)

Fig. 74 shows an instance of this, as the result of amputation high up in the humerus, in a young subject. E. D., aged 10, was admitted under my care in Guy's Hospital for a terrible crush of both upper extremities, from his having been run over by a timber-waggon. I amputated at once through the left shoulder-joint by superior and inferior flaps. An attempt was made to save the right limb, but owing to gangrene setting in amputation became necessary, and was performed high up through the humerus by Mr. G. A. Wright, of Manchester, then House-Surgeon. The resulting projection of the left acromion from wasting of the muscles was well shown when, nine years later, he again came under my care for a conical and tender stump on the right side, due here to the unbalanced growth of the upper epiphysis. (The writing below the figure was done by the lad with his teeth.)

The operation is thus described in Prof. Spence's words (*Lancet*, 1867, vol. i. p. 143; and *Lect. on Surg.*, vol. ii. p. 662): "Supposing the right arm to be the subject of amputation. The arm being slightly abducted, and the head of the humerus rotated outwards if possible, with a broad strong bistoury I begin by cutting down upon the head of the humerus, immediately external to the coracoid process, and carry the incision down through the clavicular fibres of the deltoid and pectoralis major till I reach the humeral attachment of the latter muscle, which I divide. I then, with a gentle curve, carry the incision across and fairly through the lower fibres of the deltoid towards the posterior border of the axilla, unless the textures be much torn. I next mark out the line of the lower part of the inner section by carrying an incision through the skin and fat only, from the point where my

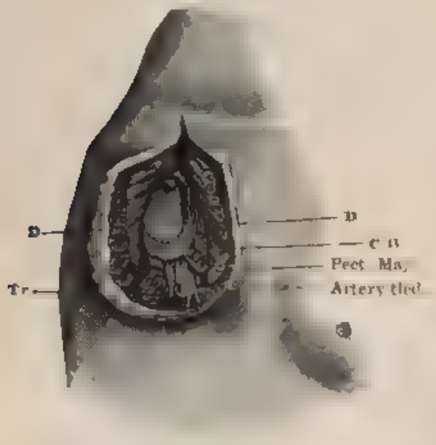
FIG. 72.



The anterior fibres of the deltoid, the insertion of the pectoralis major, and the coraco-brachialis and biceps are seen cut. The left hand of the operator draws the large nerves downwards, and thus exposes the axillary artery for ligature. Farabeuf.

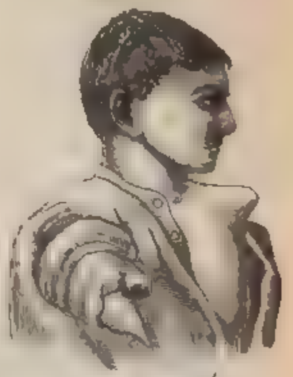
straight incision terminated, across the inside of the arm to meet the incision at the outer part. This requires accuracy in the use of the knife, but is not essential. If the fibres of the deltoid have been thoroughly divided in the line of incision the flap so marked out can be easily separated (by the point of the finger without further use of the knife) from the bone and joint together with the trunk of the posterior circumflex, which enters its deep surface, and drawn upwards and backwards so as to expose the head and tuberosities. The tendinous insertions of the capsular muscles, the long head of the biceps, and the capsule are next divided by cutting directly on the tuberosities and head of the bone, and the [illegible] of these, [illegible] being very fully exposed by the incision, can be [illegible] more easily, and completely, divided than in the double flap method. By keeping the large outer flap out of the way by a broad copper spatula or the finger of an assistant, and taking care to keep the edge of the knife close to the bone, as in excision, the trunk of the posterior circumflex is protected. Disarticulation is then accomplished, and the limb removed by dividing the remaining soft parts on the axillary aspect. The only vessel which bleeds is the anterior circumflex, divided in the first incision, and here, if necessary, a pair of catch-forceps can be placed on it at once. In regard to the axillary vessels, they can either be compressed by an assistant before completing the division of the soft parts on the axillary aspect, or, as I often do in cases where it is wished to avoid all risk, by a few touches of the bistoury the vessel can be exposed, and can then be tied and divided between two ligatures, so as to allow it to retract before dividing the other textures.*

FIG. 73.



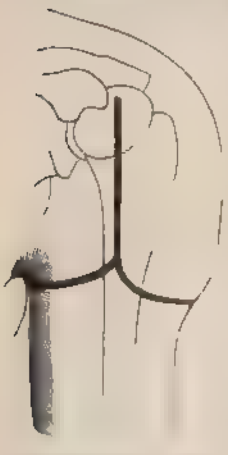
Parts composing the flaps made by the *en raquette* method. (Farabeuf.)

FIG. 74.



Edward Davies.

FIG. 75.



Amputation at the shoulder-joint by Spence's method. (Stimson.)

iii. **Amputation by Superior and Inferior Flaps** (Figs. 76 and 77).—The patient having been brought to the edge of the table, turned sufficiently over, and his shoulders supported by pillows, the assistants are arranged as before (footnote, p. 141). The arm being a little raised so as to relax the deltoid, the surgeon, standing inside the limb on the right side and outside it on the left, lifts the deltoid muscle with his left hand, and sends the knife (narrow, strong, and no longer than needful) across beneath the muscle, entering it on the right side, just below the coracoid process, and bringing it out a little below the most prominent part of the acromion,* or *vice versa*, according to the side operated upon. The knife should pass close to the anatomical neck of the humerus, without hitching upon it, and the flap should be cut broadly rounded, and well down to the insertion of the deltoid. It is then raised and retracted, and, the capsule being now exposed, the joint is opened by cutting strongly upon the head of the bone. The arm being now rotated outwards vigorously by an assistant or by the surgeon, the subscapularis, thus made tense, and the biceps are brought into view and severed; the limb is next rotated inwards, being carried across the chest, and the muscles attached to the great tuberosity are divided. The capsule is next still more freely opened, and the head of the bone, now freed, is pushed up by the assistant and pulled outwards from the glenoid cavity. The knife is next slipped behind the head (Fig. 76), and cuts its way along the under aspect of the neck and shaft of the humerus, so as to shape an inferior flap half the length of the

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* Where the limb is very muscular, Prof. Spence recommended to raise the skin and fat from the deltoid at the lower part, and then to divide the muscular fibres higher up by a second incision, so as to avoid excess of muscular tissue.

FIG. 76.

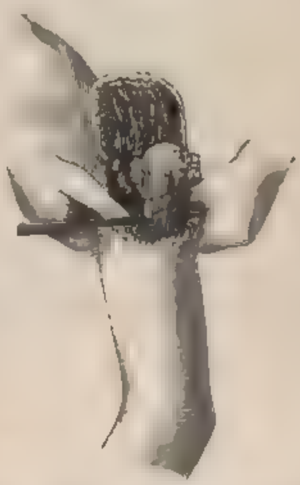
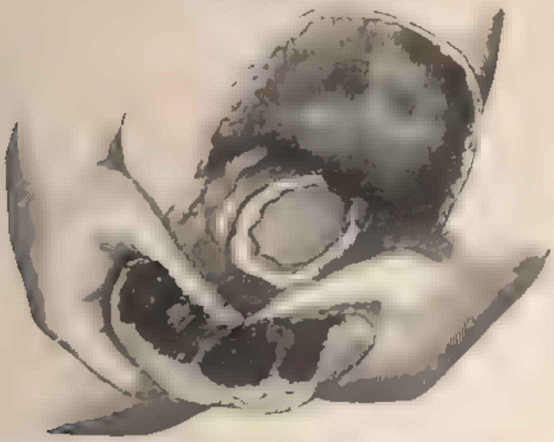


FIG. 77.



To show the manner in which bleeding is controlled in the inferior flap: the axillary vessels are compressed by one thumb, the posterior circumflex by the other.

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* Unless care is taken to keep thus below the acromion process, there will be some tendency for this bone to protrude in the wound.

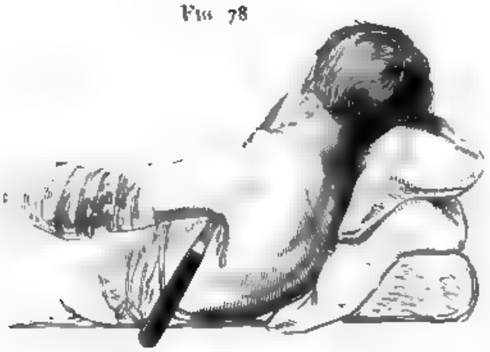
upper one.* As soon as the knife is passed behind the bone, an assistant slips his hands in behind the back of the knife (Fig. 76), following it so as to grasp firmly the soft parts in the inferior flap, and thus control the axillary vessels (Fig. 77).

The large vessels are next secured, then the circumflex, and muscular branches that require it; any large nerves that need trimming are then cut short, drainage, if necessary, provided, and the flaps brought into position.

This amputation has the advantage of being very quickly done, and of giving a flap which keeps in position by its own weight, and thus gives good drainage. If the soft parts below the humerus are much damaged, the upper flap must be cut proportionately long.

iv. **Amputation by Deltoid or Upper Flap.**—This is merely a modification of the last. The deltoid or upper flap may be cut by transfixion, or made by cutting from without inwards. In either case it must be of very full size, and thus is useful when the axilla is damaged, but it has the disadvantage of leaving next to no flap in which an assistant can seize the axillary vessels; and, owing to the powerful retraction of the muscles in the axillary folds, unless the upper flap is cut full in length and size it will not cover the resulting wound. Finally, as the trunk of the posterior circumflex is cut, sloughing of the large deltoid flap may take place, especially if the tissues composing it are at all damaged previous to the amputation. Owing to these disadvantages, which outweigh its rapidity, this method is not to be recommended, a short under-flap being always cut if possible. When the surgeon, having disarticulated, is cutting straight down, unable to make any flap below, assistant No. 2 (footnote, p. 141) should try to draw up the skin of the axilla, while assistant No. 1, in charge of the limb, should be careful not to draw down the skin, otherwise, owing to the laxity of the skin in the axilla, any downward traction will bring the skin of the thoracic wall under the knife.

FIG. 78



(Fergusson.)

v. **Amputation by Anterior and Posterior Flaps** (Fig. 78).—This is indicated when the soft parts on the front and inner aspects are damaged. The position of the patient being as advised at p. 146, and the limb being carried somewhat upwards, backwards, and outwards, the surgeon, standing, if on the left side, behind and outside the shoulder, enters his knife just in front of the posterior fold of the axilla, thrusts it across the back of the humerus as near the head as possible, so as to get in front of the tendons of the teres major and latissimus dorsi, and bringing it out close to the acromion, cuts, with a sawing movement, a flap 4 to 5 inches long,* which is next well retracted by an assistant. The arm being then carried across the chest, the joint is freely opened behind, the muscles attached to the tuberosities severed, the knife passed between the head and the glenoid cavity (to facilitate this, the limb should now be carried over the chest, and the head of the bone pushed backwards), then between the bone and the pectoralis major, and an anterior flap,† 4 inches long, cut from within outwards. Hæmorrhage from the large vessels is arrested either by an assistant grasping this flap as it is cut, much as at p. 147, Fig. 76, or by the surgeon isolating the axillary vessels (the biceps and coraco-brachialis will guide him) and securing them by torsion or ligature (p.143) before he completes the operation by cutting the anterior flap. When operating on the right limb, the patient being turned well over on to his left side, the surgeon, standing here inside the arm, which is held upwards and backwards so as to relax the deltoid, lifts this muscle up with his left hand, and then passes his knife from just below the acromion, transfixing the base of the deltoid, grazing the back of the humerus, and finally thrusts the point downwards and backwards through the skin till it comes out at the posterior margin of the axilla. This flap, 4 or 5 inches long, should be dissected up, the joint opened behind, and the operation completed as before.

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* The surgeon should not cut this till he is told that the flap is held firmly; and, in cutting it, he must be careful of his assistant's fingers.

vi. **Furneaux Jordan Method.**‡—This may be made use of both as a primary and a secondary amputation. The following are suitable cases:

a. Certain cases of injury.—Where, though the parts about the shoulder-joint are intact, the humerus is badly split up into the joint. The soft parts are divided down to the bone by the circular method, 3 to 4 inches below the axilla, the main vessels secured, and the humerus then shelled out by a longitudinal incision along the outer and posterior aspect of the limb, meeting the circular one at a right angle.

b. In cases of failed excision.—Here, after amputation of the limb by the circular method, the rest of the bone is turned out through the excision wound prolonged into the circular one.

c. After amputation in the middle of the arm in some cases.—*E.g.*, when the stump is the seat of osteo-myelitis, necrosis, or otherwise does not do well.

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* In the posterior flap will be the posterior part of the deltoid, the latissimus dorsi, and teres major.

† In this anterior flap will be the remaining fibres of the deltoid, the pectoralis major, and the large vessels and nerves.

‡ For the details of this method see "Amputation at the Hip-joint."

EXCISION OF THE SHOULDER-JOINT (Figs. 79 to 85).

This operation is but rarely performed—(1) owing to the comparative infrequency of diseases of the above joint, especially of tubercular disease, which require operative measures; (2) from the fact that epiphysitis and septic synovitis usually give, after free incision and drainage, as good a result as can be obtained after excision. This is mainly owing to the fact that much of the stiffness that otherwise would be present is made up for by the supplementary mobility of the scapula, especially in young subjects.*

The above remarks naturally lead up to the consideration of *the amount of movement which is gained after the operation of excision.* The arm cannot usually be abducted and elevated beyond the horizontal line; too often it lies close to the chest. Even if the deltoid retained its power of elevation, it could not often exert it, as in most operations, owing to the amount of bone removed, the fulcrum of the head of the humerus against the glenoid cavity has gone. Prof. Longmore (*Resection of the Shoulder-joint in Military Surgery*, p. 12) writes:—"The loss of the elevating action of the deltoid must be accepted, like the loss of the rotating power from the division of the muscular insertions into the two tubercles, as a necessary consequence of resection of the head of the humerus. But the holding or supporting power of this muscle exerted upon the whole upper extremity owing to its position, its extensive origin, and the manner in which it embraces and protects the mutilated parts, as well as its faculty of assisting in carrying the arm backwards and forwards, are all functions which may still remain, and serve to point to the great importance of preserving its integrity as fully as possible. The wasting of the internal fibres (footnote, p. 160), however, seems a necessary result of resection by the single incision, but it has this compensating feature, that it is a less serious loss to the patient than an atrophied condition of the outer and posterior fibres would be, because the upper clavicular fibres of the great pectoral can take the place of the inner deltoid fibres to a considerable extent in supporting the shoulder and drawing it forwards to the chest."

Sir J. E. Erichsen (*Surgery*, vol. ii. p. 251) says of the four chief movements of the shoulder-joint—viz., "(1) abduction and elevation, (2) adduction, (3) and (4) movements in the antero-posterior direction —these are requisite in all ordinary trades for the guidance of the hand in most of the common occupations of life. The movements of elevation are seldom required save by those who follow climbing occupations, as sailors, masons, &c. Now, the mode of performing the operation, as well as the operation itself, will materially influence these different movements. Thus, if the deltoid be cut completely across, the power of abduction of the arm and of its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision, they may be regained in great part. All those movements of rotation, &c., which are dependent on the action of the muscles that are inserted into the tubercles of the humerus will be permanently lost; for, in all cases of caries of the head of the humerus requiring excision, the surgeon will find it necessary to saw through the bone below the tuberosities—in its surgical, and not its anatomical, neck.* Hence the connections of the supra-spinatus and infra-spinatus, the teres minor, and subscapularis will all be separated, and their action on the bone afterwards lost. But those muscles which adduct, and which give the antero-posterior movements—viz., the coraco-brachialis, the biceps, the pectoralis major, latissimus dorsi, and teres major—will all be preserved in their integrity; and hence it is that the arm, after this excision, is capable of guiding the hand in so great a variety of useful under-handed movements."

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* In future, by the use of a simple longitudinal incision with a minimum of interference with the deltoid, aided by antiseptic precautions from the first, and with earlier and persevering adoption of passive movements, the above statement may have to be

Indications.

i. Different forms of arthritis disorganising the joint, resisting careful treatment, in subjects whose age, general condition, &c., are satisfactory—viz.:

(*a*) Tubercular disease, resisting other treatment and going on to caries. (*β*) Disorganisation of the joint after rheumatic fever, gonorrhœal rheumatism, wrenches, &c., resulting in crippling ankylosis, in a young subject. (*γ*) Osteitis going on to suppuration, caries, &c. (*δ*) Epiphysitis, suppurating or acute necrosis, where the discharge, necrosis elsewhere, suppurating arthritis, &c., are exhausting the patient, and the outlook as to natural cure is not good. (*ε*) Disease of the deltoid bursa ulcerating into the joint and setting up destructive arthritis.

ii. Gunshot injuries, where the large vessels and nerves have escaped, where fragments of shell, bullets, &c., are lodged in the head of the bone, especially if the shaft of the bone is not much damaged (p. 135).

iii. Compound dislocation and compound fracture with much damage to the capsule and cartilage of the head of the bone, the large vessels and nerves being intact.

iv. Some cases of ankylosis—*e.g.*, after acute rheumatism or traumatic arthritis and suppuration. Here the question of operative interference will mainly turn on how far the additional movements of the scapula and humerus together have made up for the ankylosis, and the degree of atrophy of the muscles.

Dr. E. Souchon, of New Orleans, to whose masterly article on operative interference in Irreducible Dislocations of the Shoulder-joint I refer at p. 153, has dealt with the treatment of ankylosis of this joint as helpfully in another article (*Trans. Amer. Surg. Assoc.*, 1896, p. 409). He considers that operation is only justifiable in recent cases in full-grown subjects or in patients of sufficient age to ensure that the removal of the head of the humerus will not be followed by too great shortening. It is especially indicated in ankylosis following arthritis with a rapid course (dry, acute arthritis), observed sometimes in subjects affected with acute rheumatism, and especially blennorrhagic arthritis; also in cases consecutive to suppurating traumatic arthritis. In these cases the ankylosis occurs before the atrophy of the muscles. The cases of ankylosis which should not be operated on are—(1) those with a fairly useful limb as it stands, unless there is positive assurance of improving the movements, especially those that are particularly needed for the patient's work; (2) where atrophy of the muscles is present. The application of electricity and massage may be required for some time before it is decided that the operation will be useless. Operation is contraindicated especially when the muscles are irretrievably degenerated, such as is the case in a great number of old ankyloses, and particularly those following long articular suppuration.

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* With all proper deference to the opinion of Sir J. E. Erichsen, this opinion appears to be too definite and inelastic. I would refer the reader to the remarks below on the site of section of the bone, and on subperiosteal resection (pp. 162, 166).

v. Some cases of unreduced dislocation of the head of the humerus. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 738) wrote long ago:—"I have often thought that, in cases of irreducible dislocation attended with much pain, the removal of the head of the bone might be justifiable, but have not met with any case in which the operation has been performed."* Lord Lister (*Edin. Med. Journ.*, March 1873) excised the head of the humerus after securing a rupture of the axillary artery,† this vessel having given way in an attempt to reduce a dislocation of eight weeks' standing. The patient, aged 58, sank three hours later. Considering the frequency with which this accident has taken place in attempting to reduce old dislocations of the shoulder, it would be wiser, in these days of antiseptic surgery, to attempt to improve the condition of things by excising the displaced head. Mr. Sheild brought before the Medico-Chirurgical Society (*Trans.*, vol. lxxi., 1888, p. 173) a man, aged 45, on whom he had performed excision for a neglected subcoracoid dislocation of twelve weeks' standing.

Owing to pressure on the median and ulnar nerves, the hand was almost useless. Moderate attempts at reduction having failed, the head was removed through the anatomical neck, this site being chosen in order to disturb the parts as little as need be. The end of the bone was made as like the real head as possible by careful rounding. Twelve weeks afterwards the patient was able to resume work as a waiter. The movements of the shoulder were satisfactory, and the hand gradually regained strength.

Lord Lister published (*Brit. Med. Journ.*, 1890, vol. i. p. 1) two similar cases treated by operation, but somewhat differently.

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* While this operation is one of recent date in England, credit should be given to those surgeons who have practised it, years ago, elsewhere. Cases will be found recorded by Post, of New York, in 1861; by Warren, of Baltimore, in 1869. In Germany, Langenbeck, Volkmann, Cramer, Kuster, Kronlein, and others operated for recurrent dislocation and old dislocation of the humerus. M. Léon Tripier published a successful case of resection of the head of the humerus, which, fractured as well as dislocated, was pressing on the brachial artery and threatening gangrene. A full bibliography is appended to Dr. Souchon's article, the best on this subject (*vide infra*, p. 153).

† The condition of the parts found here is most noteworthy. A broad and strong fibro-osseous band, connecting the humerus with the coracoid process, lay over the head of the bone, and at the same time was intimately connected throughout by condensed tissue with the sheath of the axillary artery, which lay over it. Thus the vessel, instead of being surrounded by loose and yielding structures, was attached by a fibro-osseous band to the coracoid process on the one hand, and the neck of the humerus on the other; and when these were separated from one another by the attempts at reduction, the artery as well as the band was subjected to violent traction. Accordingly, the band, strong as it was, was found to have been torn right across, and the rent in it was exactly opposite to the rupture in the artery. Atheroma in the vessel served to explain still further the disaster.

They were both instances of bilateral sub-coracoid dislocation, due in the one case to a fall from a tree, in the other to epilepsy. The patients, aged 47 and 23, were each pitiably helpless. In three of the joints, the usual incision having been made between the deltoid and pectoralis, the subscapularis tendon was divided, and the soft parts detached from the head of the bone and the inner side of its neck. This was done to ensure the vessels being entirely set free from the head of the bone. The pulleys were next used, and, the head not returning, it was protruded out of the wound, and the insertions of the external rotators cut through, after which the pulleys were used successfully. In the case of the fourth joint the articular portion of the head was removed piecemeal with a chisel, without interfering with the tuberosities or the external rotators. This allowed the head to drop readily into the glenoid cavity. The result of these operations was "a grand success," but the operator thought that excision gave a result inferior to the other.

In Lord Lister's words (*loc. supra cit.*, p. 3):—

"The attachments of all the rotators to the tuberosities were divided, and yet you saw that they have completely re-formed; rotation is perfect, both external and internal. And in the other patient, though the dislocation had been of so much longer standing (seven months), the use of the previously wasted rotators had been completely restored. I would advise that when the surgeon feels in doubt as to whether it is prudent to make attempts at reduction, or when such attempts do not succeed, he should, in the first place, cut down upon the bone by the usual incision from the coracoid process downwards and a little outwards, and then, with a curved periosteum-detacher, freely separate the soft parts from the inner side of the upper end of the humerus. You will then be sure that no damage will be done to the axillary vessels in any manipulations which you may make. In many cases you will doubtless succeed by these means; but if this fails, then these instances show that you may proceed to turn out the head of the bone, detaching the insertion of the rotator muscles, and after reduction you will have a thoroughly useful limb. Should even this procedure fail, removal of the head of the bone is easily open to us, with the promise of a good though inferior result."

It is noteworthy that in the case of reduction without excision there was a remarkable tendency to the formation of adhesions, and the recovery of movement was extremely slow. In another, the maintenance of passive movement kept up a serous oozing and delayed the healing of the wound. In the only case in which the date is given at which passive movements were begun, this is stated to have been the thirteenth day. Anæsthetics were required twice, and the recovery of power was extremely slow. Massage and galvanism aided greatly in the improvement. Strict antiseptic precautions are needful throughout, as, if inflammation sets in, ankylosis is almost certain.

Mr. Pearce Gould and Mr. Watson Cheyne showed similar cases at the Medical Society (*Lancet*, 1892, p. 474).

Reduction was in each case effected after division of the muscles. In one case the range of movement was somewhat defective, and there was a tendency for the head of the humerus to slip forward. But here four months had elapsed between the dislocation and the reduction; it was needful in this case to clear out the glenoid cavity, and the patient failed to attend subsequently.

Mr. Thorburn (*Med. Chron.*, vol. xiv. p. 8) excised the head of the humerus through the surgical neck, in a case diagnosed as subclavicular dislocation and fracture with irregular formation of callus. He points out that division of tendons would here have been insufficient, as such a deformed head, if even thus reduced, would not have fitted into the glenoid cavity.

The most complete and helpful contribution on this subject is a paper by Dr. E. Souchon, of New Orleans, "Operative Treatment of Irreducible Dislocations of the Shoulder-joint, Recent or Old, Simple

or Complicated" (*Trans. Amer. Surg. Assoc.*, 1897, p. 311). This is a most elaborate and helpful study, based on 154 cases of operation, and abounds with those details which are so valuable to surgeons who may have to deal with these occasional but most difficult cases. The following are the chief conclusions of Dr. Souchon:—"The anterior incision is the route. Reduction is the more desirable operation, because it preserves the head and all the movements depending therefrom. Reduction should be done only in cases where the head and glenoid cavity are in good condition; when no extensive dissections have to be made; when it is easily effected without any great effort; when the head does not need to be trimmed, or the cup to be too deeply scooped or enlarged; when the head readily remains in place, but not too tightly. All this regardless of the time or standing of the dislocation. It should, however, always be attempted conscientiously, because many have resected, perhaps, when the dislocation could have been reduced.* Disregard of these rules may result in necrosis of the head, in recurrence of the dislocation, or in ankylosis, with their inevitable consequences. Resection should be practised in all other cases. When in doubt, it is preferable to resect. How much to resect—*i.e.*, when to saw through the anatomical neck or obliquely and downward outside the tuberosity, or horizontally on a level with the lower margin of the head—must be determined in each case; it is better to remove too much than too little. Of course, all efforts should be made to secure aseptic results. A most important point is to get primary union."

Amongst **the difficulties of reduction,** the following instances are given:—The capsule may be replaced by a thick fibrous mass, the head having thus lost its "right of domicile." Adhesions of the capsule to the glenoid cavity. Such complete healing of the rent in the capsule as to prevent reduction. Strong adhesions between the new cavity and the neck or head of the humerus. Such bands may be adherent to the vessels and nerves. Sclerosis of the muscles, rendering their section necessary. Alteration in the shape of the head of the humerus. Usually several of the above causes combine to interfere with reduction or resection.

Dr. Souchon's elaborate article shows that amongst *the difficulties and complications which may be expected during the operation* the chief are:—A very thickened capsule or much fibrous tissue about the head of the humerus, necessitating a tedious dissection, with persistent oozing. The head may lie very deep, and be adherent to the adjacent parts, *e.g.*, the ribs, and the deeper the position the greater the risk of serious hæmorrhage. When thus firmly fixed the head may be prised into its natural position by elevators, scoops, or blunt scissors, and this failing, division of the bone may be needful, the head being then lifted out by the above-mentioned instruments or loosened with lion-forceps. In other cases it may be wiser to remove it piecemeal. The glenoid cavity may be so filled up as to need refashioning.* The packet of vessels and nerves may lie across the head of the bone. In the manipulations needful to get the head into place, the neck of the humerus may give way.

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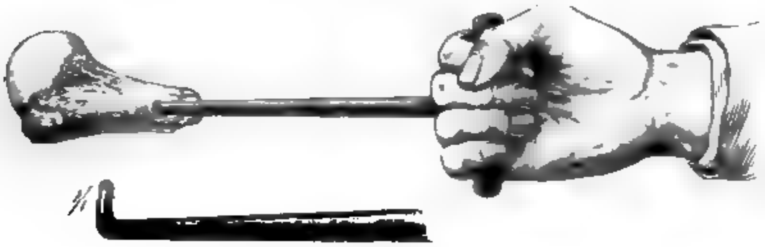
* In young subjects reduction should always be preferred to resection, and if the latter is employed, the epiphysial cartilage should not be injured, if possible. At p. 349 of Dr. Souchon's paper a case (reported by I. Wolff, *Berl. klin. Woch.*, 1886, SS. 897-903) of downward dislocation is recorded, due to a severe accident. There was paralysis of the muscles, so that a finger could be pushed between the head and the acromion. A thin layer of cartilage having been chiselled off the humerus and glenoid cavity, the two were wired together. Four months later the improvement was marked. Dr. Souchon also refers to three cases of dislocation occurring in very early life, and perhaps due to injury at birth, treated by resection.

As *results of the operation*, hæmorrhage, gangrene, necrosis and a sinus, and exfoliation of cartilage have occurred. The death-rate is given as 10 per cent. in reductions and 12 per cent. in resections; and while, no doubt, this will be diminished with the advantages of modern surgery, those who study carefully the difficulties which may beset this operation, especially in long-standing cases, will always look upon it as by no means a light one.

It remains to consider very briefly the question of surgical interference in that rare combination of accidents, viz., fracture of the upper part of the humerus and dislocation of the head. If reduction is found impossible, operative interference will be justifiable in a healthy and actively employed patient, and when the conditions necessary for complete asepsis are present. Reduction of the dislocation by such an incision as that given at pp. 157, 160, and suture of the fracture, will be preferable in recent cases to resection of the fractured head. If union fails and the joint is useless, resection should be performed at once. And the same step should be taken as a secondary operation when all acute symptoms have subsided and it is clear that serious disability and pain are caused by the dislocated head. To meet the difficulty of bringing the upper fragment into position, Dr. C. McBurney, of New York, has made use of the traction-hook (Fig. 79) which bears his name.

FIG. 79.



McBurney's traction-hook for the reduction of fractured and dislocated bones.

The case was one of oblique fracture of the neck of the humerus, the upper fragment being dislocated under the coracoid process, and by its small size resisting all attempts at dislodgment and replacement. Dr. McBurney two weeks after the injury, exposed the fragment, drilled it, and readily reduced it with his traction-hook. A perfect result followed (*Ann. of Surg.*, 1894, vol. i. p. 399).

vi. Recurrent dislocation of the shoulder. Dr. Burrell and Dr. Lovett, of Boston, have contributed a paper on this subject, with six cases, two of which were operated upon, with an excellent result in each case (*Trans. Amer. Surg. Assoc.*, 1897, p. 293). This is occasionally met with in patients who have not given the joint sufficient rest at first, or in those who are the subjects of epilepsy. Amongst the pathological conditions, which vary widely, these writers consider the following to be established: (1) Laxity of the capsule; (2) Tearing away of the capsule from the glenoid cavity; (3 and 4) Partial fracture of the head of the humerus or the glenoid cavity; (5) Tearing away of muscular insertions.

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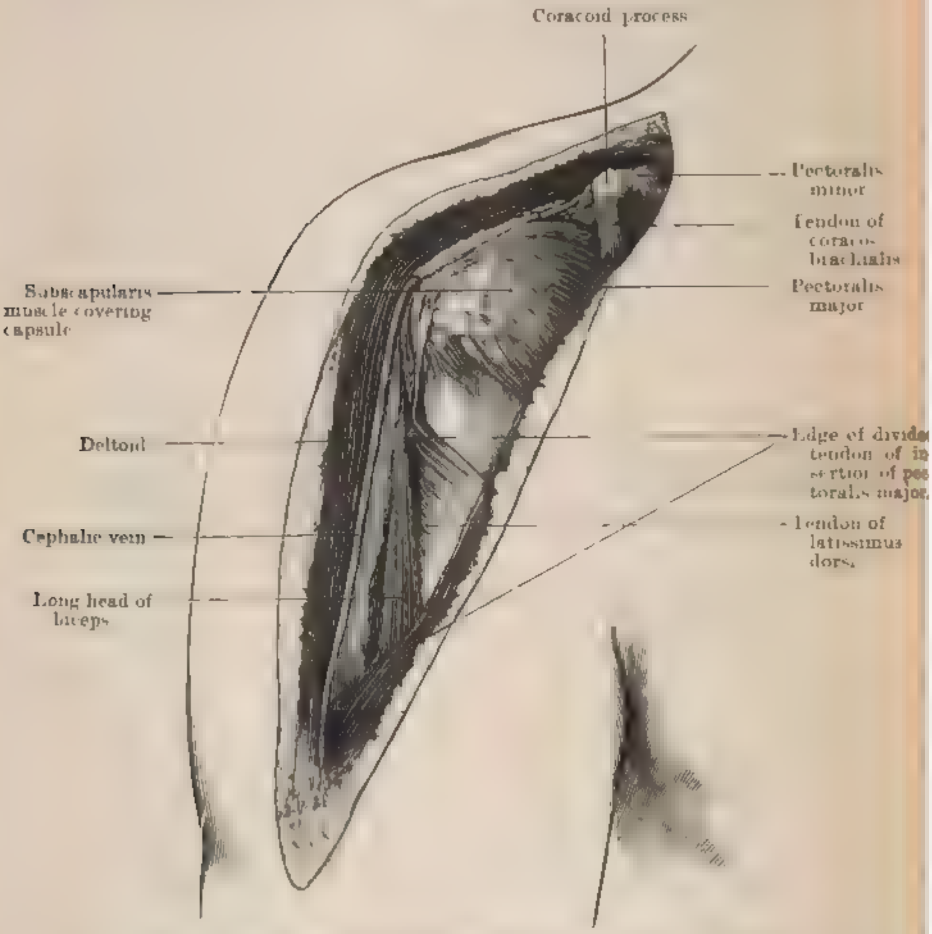
* If both the glenoid cavity is refashioned and the head of the humerus resected, and the two are then placed in contact ankylosis may follow.

FIG. 80.


Coracoid process
Pectoralis minor
Tendon of coraco-brachialis
Subscapularis muscle covering capsule
Pectoralis major
Deltoid
Edge of divide tendon of in sertion of pec toralis major.
Cephalic vein
Tendon of latissimus dorsi
Long head of biceps

Field of operation in habitual dislocation of the shoulder. (Burrell.)

e.g., the spinati, or rupture of the biceps tendon; (6) Altered shape of the head of the humerus, probably the result of chronic inflammation. The following are the chief steps of the operation performed by Dr. Burrell in the two cases referred to above. Where a trial of primary fixation for a few weeks combined with massage of the muscles, followed by careful movements of the joints, fails after ten weeks, partial resection and suture of the capsule* is recommended, unless any abnormalities be found which require removal of the head of the humerus. A free incision having been made in the pectoro-deltoid interval, the cephalic vein drawn aside, the coraco-brachialis and biceps are recognised in the upper and the pectoralis major in the lower part of the wound. Division of the upper three-quarters of the insertion of the latter muscle is recommended so as to expose thoroughly the head and neck of the bone. The long tendon of the biceps will be seen and felt through its sheath. The incision should be carried in its whole depth up to the coracoid process, and the tendons of the biceps and coraco-brachialis cleared up to this point. By rotating the head outwards and dropping it backwards, the insertion of the subscapularis is stretched over the head of the bone. A portion of this insertion should be divided. The arm is next abducted, raised to a horizontal position, and the head of the bone pressed backwards so as to prevent its coming up under the coracoid process, which it tends to do in these cases, and also to relax the front of the capsule. If the joint appear normal the loose part of this ligament is then grasped with vulsellum forceps, and a fold three-quarters of an inch in length and three-eighths of an inch wide excised. The gap is then sutured, rendering the capsule distinctly tighter and shorter.

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* The credit of first taking this step is due to Dr. Gerster, of New York.

Mr. Southam (*Brit. Med. Journ.*, vol. ii. 1892, p. 1193) published a case in which he had excised the shoulder-joint for a frequently recurring dislocation in a woman, aged 45.

Nothing abnormal, beyond slight grating, could be detected on examination, but, under anæsthesia, a sub-coracoid dislocation could be readily produced, and as readily reduced. At the operation a small part of the anterior rim of the glenoid cavity was absent. The head of the humerus was sawn through the anatomical neck; gentle passive movements were begun three weeks after the operation, and twelve months later there had been no recurrence of the dislocation. The arm was then very useful, with good movements, the patient being able to perform her ordinary household duties.

vii. A few cases of growth (*e.g.*, exostosis, chondroma, myxo-chondroma, myeloid growths, and ossifying sarcoma) connected with the upper extremity of the humerus. Whilst the priceless value of the hand fully justifies the attempt in some instances, such cases must be extremely rare.

Perhaps it is owing to this rarity that this matter has received so little attention.

The best reported English case with which I am acquainted is one in which Sir W. Mitchell Banks* endeavoured to save the upper extremity of a patient by excising the upper end of the humerus, the site of a sarcomatous growth originally enchondromatous.

"S. D. was a spare, placid man of 56, a chapel-keeper. So far back as the summer of 1865 he was seized with violent pain near the right shoulder, and after that came a hardness and swelling at the top of the humerus, which very slowly increased. As it gave him no great inconvenience, he did not heed it much for many years, but by 1878 it had grown to be as big as a cocoa-nut, so that, on attempting to raise the arm, it became locked against the acromion, limiting movement, while pain of a severe character set in. In June 1878 the tumour was removed by cutting down upon it, and dissecting off the tissues from over it. As it grew from the outer surface of the upper third of the humerus, this was effected without difficulty. Then with a mallet and chisel it was cut cleanly away from the bone, and the surface from which it sprang was thoroughly scraped—a pretty broad surface, by the way. I left no cartilaginous remains that could be seen. The patient rapidly recovered, but in the track of the wound a sinus or two persistently remained, leading down to the bone. After the lapse of about two years it became clear that the tumour was returning, and by the summer of 1881—three years after the first operation—it had attained an immense size, having taken a fit of growing during the last few months. It clearly arose from the same site as before, but now it filled up the axilla, and had even got beneath the great pectoral. Pain and rapidity of growth demanded its speedy removal. But the removal of a whole right arm at the shoulder-joint seemed such a dreadful thing, that one was anxious to save a hand and forearm by carrying away, if possible, the tumour and upper part of the humerus, even although the upper arm might remain useless. The patient being made well aware that, in case of the failure of this project, there was nothing left but amputation, I attempted it. The incisions necessary to lay bare the tumour were very extensive, the chief one reaching from above the acromion, half-way down the outer side of the upper arm. With much trouble, and after the loss of a great deal of blood, the outer and upper surfaces of the growth were exposed, and the humerus was disarticulated from the scapula. Then, sawing through the humerus, about an inch below the deltoid insertion, I attempted to dissect away the tumour from the brachial vessels and nerves. Here, however, most serious difficulty was encountered, from their intimate incorporation with the growth, and at last, after a prolonged attempt, I was reminded by my colleague, Mr. Harrison, that the patient had plainly endured as much as he could, and that to make further effort might only lead to collapse on the table. I was reluctantly compelled to admit this, and so rapidly swept the limb away at the shoulder. So profound was the shock, that a short time after the operation the temperature fell to 95°, and remained so for many hours. The operation was conducted antiseptically, and the patient, in spite of the loss of blood, made such a rapid recovery that on the twenty-third day he left the infirmary quite well, and remains so now, two years after the amputation. If the great vessels and nerves had not been so seriously enveloped by the growth, the limb would have been saved, although with the loss of the upper half of the humerus. But even a forearm is better than no arm at all. The case also shows that chiselling off cartilaginous tumours is not by any means a certain removal. The surface that was left upon the humerus, after the first removal of the tumour, looked perfectly healthy to the naked eye, but there must have been cartilage cells deep down in the tissue of the bone."

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* *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 6. It is much to be desired that this original and most instructive writer would give to the profession, with equal vigour and terseness, some more of his experience.

Mr. Southam (*Med. Chron.*, Jan. 1887, p. 291) has recorded a successful case of resection of the upper end of the right humerus for an endosteal (mixed-cell) sarcoma:

A large deltoid flap was made, and the head and 4 inches of the shaft of the humerus removed. Six months later, the patient, aged 30, could raise her hand to the mouth, and employ her arm for household work and in using a small sewing machine. Though, with the arm hanging by the side, there was an interval of about 4 inches between the acromion and upper end of the humerus, the distance could be considerably diminished by the action of the biceps and triceps, and coraco-brachialis. A good illustration accompanies this instructive case.

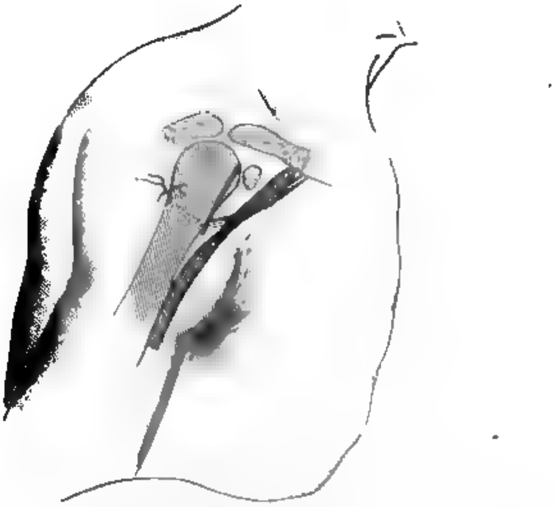
M. Ollier (*loc. supra cit.*, t. ii. p. 57) mentions a most interesting case in which, by early intervention, resection of the upper half of the humerus for a sarcoma, central and subperiosteal, saved both the life and the limb of a child, 6½ years old. The growth dated to a fall upon the shoulder, and made its first appearance as a filbert-like swelling close to the insertion of the deltoid. As the swelling increased slowly and resisted treatment, it was explored by M. Heurtaux. The sarcomatous nature of the swelling having been made clear, the upper half of the humerus was removed, this step being thought safer, thc [illegible] e joint itself was not involved. No enlarged glands could be f [illegible] xilla.

Three years later the condition, locally and generally, was excellent. There was no reproduction of the part removed. The resected end terminated in a small osteophytic prolongation joined to the scapula by a fibrous band. The humerus was thus unable to find any steadying point so essential for its movements. The limb was therefore a flail, but a very useful one, thanks to the mobility of the elbow and fingers, and to a supporting apparatus.

Mr. J. Hutchinson has recorded (*Path. Soc. Trans.*, vol. viii. p. 346) a case of resection of the upper part of the humerus for a large myeloid growth. The following is a summary of the case:

Supposed fracture of the neck of the humerus in a woman, aged 27. Permanent loss of movement and gradual enlargement above the spot. Amputation at the shoulder-joint advised fourteen months after the accident, on account of a large tumour which had formed—refused by the patient. Arrest of the growth for four years. Subsequent rapid growth, and enlargement of the glands. Resection of the upper third of the humerus, and removal of the diseased glands. Recovery, with a useful arm, but rapid reproduction of the disease. Death, five months after the operation, from an enormous mass, with sloughing and bleeding. Secondary growths connected with the bone, axilla, cervical glands, and lung.

FIG. 81.



Excision of shoulder-joint by a straight incision placed just outside the coracoid process.—Péan, *De la Scapulalgie et de la Résection scapulo-humérale* (Paris, 1860) This cut is inserted to remind my readers that the circumflex nerve and posterior circumflex vessels cross the humerus at the surgical neck, on a level that corresponds to a horizontal line drawn about a finger's breadth above the centre of the deltoid

Methods.

i. By an anterior straight incision (Figs. 80 to 85); usually anterior.
ii. By a posterior incision, straight or curved.*
iii. By a deltoid flap.

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* Posterior incisions, straight or curved, have been used by some German surgeons. Some of these, especially Kocher's, allow of a very free inspection of the joint. But they are either, if safe, complicated, as in that of Kocher, which entails division of the spine of the scapula, or unsafe by damaging the deltoid and circumflex nerve As tuber-

The first only need be referred to at any length here. The second is a complicated method, and the third interferes so seriously with the after-power of the deltoid that the indications for its use must be of the rarest.

i. **By Anterior Incision.**—The patient being rolled a little over, and the humerus abducted from the trunk to an angle of 60° or 80°, according to the mobility of the joint, the surgeon, standing at the shoulder facing the body, with an assistant opposite to him, and another seated to manipulate the limb, makes an incision, 3½ inches long, commencing at the base of the coracoid process, and on a level with it, through skin and fasciæ; the interval between the deltoid and great pectoral[*] is then looked for, and opened up for the same length, retractors inserted, and, if the arm has been rotated outwards, the bicipital groove will usually be seen lying at the bottom of the wound.[†] The condition of this important tendon will vary much: (1) it may be normal; (2) it may be surrounded with tubercular material; (3) it may be frayed and adherent to the bone; (4) it may be ulcerated or absent.

The bicipital tendon having been identified, the capsule is opened by a free incision, the head examined with the finger, and the incision in the capsule next carried downwards along the bone just outside the bicipital groove to the level at which it is proposed to saw the bone. With a sharp-pointed curved periosteal elevator (Fig. 52) the three muscles attached to the greater tuberosity are now carefully detached from it. The assistant in charge of the limb by strenuous rotation inwards brings each part of the tuberosity in contact with the elevator. The operator next turns his attention to the lesser tuberosity, the limb being now rotated outwards, and separates the attachment of the subscapularis. The left thumb, aided by retractors, protects the soft parts. The biceps tendon and its sheath, if healthy, are detached bodily with the soft parts and the periosteum on the inner aspect of the incision. If diseased the sheath must be opened, and the tubercular material removed with curved scissors or a curette while the tendon is carefully held aside with a blunt hook or aneurysm-needle. In detaching

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cular disease of this joint, which alone would need access to every part of the joint, is not common, and as the anterior method by a free incision and the careful use of retractors allows of sufficient access to the joint, I have described this method alone.

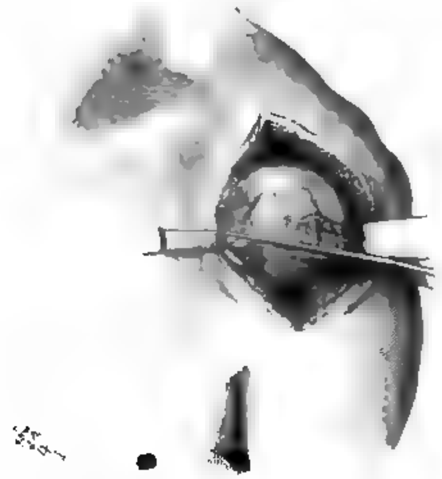
[*] The advantage of an anterior incision starting from just outside the coracoid instead of from the acromion is that the deep incision is made either in the intermuscular space or through the anterior fibres of the deltoid. In the latter case all the posterior and outer part of the deltoid (so powerful in abduction) is left intact, together with the circumflex vessels and nerve, with the exception of the terminal filaments going to the anterior part of the muscle, which alone is interfered with. M. Ollier (*loc. supra cit.*) prefers the incision through the anterior part of the deltoid, as owing to the varying width of this muscle the above interspace does not always correspond to the coracoid process, and because the cephalic vein lies between the muscles. Where the soft parts are much swollen and where the arm cannot be abducted so as to bring the deltoid into relief, the operator must take as his landmarks the position of the coracoid process and the junction of the upper and middle third of the shaft of the humerus, and make his incisions carefully. If the incision in the muscular interspace does not sufficiently expose the joint, a flap of deltoid may be turned outwards, as in Fig. 63.

[†] Farabeuf advises, to ensure the bicipital groove being found easily, that the arm be kept midway between abduction and adduction, a position secured by placing the hand (the body being horizontal) on the anterior superior spine.

the tendons, and also, later on, in sawing the bone, if this be done *in situ*, care must be taken, by keeping the arm somewhat separated from the body, and the elbow a little raised, to relax all the parts of the capsule. Unless this be done, the edges of the wound in the capsule are stretched tight, the finger is nipped, and there is no room for working with a saw, knife, or elevator.

The bone may be divided in two ways:—(1) *In situ* (Fig. 82). A blunt director is passed under the bone from within outwards, so as to protect the soft parts; the bone is completely sawn through with a narrow-bladed or a chain saw, seized with lion-forceps, and twisted out, the levering movements of an elevator, or a few touches of the knife, aiding this. The actual bone section (p. 162) should be made so as to remove the worst of the disease; usually it will pass through the tuberosities, any remaining mischief being dealt with by the gouge. (2) The head is first thrust out of the wound by pushing the elbow upwards and backwards, and then sawn off. This method is certainly the easier, but disturbs the soft parts more.[*] The former is perfectly safe, and inflicts less damage on the surrounding tissues; finally, where ankylosis is present, it may be most difficult to thrust the head out.[†] Mr. Treves, on the other hand, considers that this method is less precise, that it gives little opportunity of fully examining the parts, and that the tissues around may be damaged by the saw. Whichever plan is adopted, the soft parts should be scrupulously protected. The truncated end of the

FIG. 82.



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[*] It must not be forgotten that these soft parts are largely made up of important nerve cords. I have seen this operation followed by tetanus in a case in which the surgeon was obliged to rely on most inadequate instruments.

[†] In one of M. Ollier's cases, as the head of the humerus was being rotated outwards so as to facilitate the detachment of the subscapularis, the bone, which was very fragile, was broken across just above the condyles. This accident ultimately exercised no untoward influence on the result.

shaft should be carefully rounded off with saw or cutting-force especially in the neighbourhood of the nerves, and Mr. Sheild's plan trying to reproduce the shape of the old head may be adopted.

The deltoid flap gives more room, and thus facilitates the operati considerably, but the larger scar, and far greater, in fact almost tot impairment of deltoid power, are such serious drawbacks* that it nowadays, hardly ever used. If the head of the humerus is very mu shattered, if the soft parts are much matted and thickened, if there any special reason for completing the operation rapidly, in the ra cases of excision attempted for large growths, for the sake of m complete exposure (p. 157), this method may, though very seldom, made use of.

SITE OF SECTION OF THE BONE (Fig. 82).—It being most importa to leave the humerus as long as possible, not an atom more than needful should be removed. The section should be made just below t articular surface in every case where this will remove the whole of t disease, and where all the head must go. The advantages of sawi here over division through the surgical neck are—(1) A longer hume is left to be brought against the glenoid cavity, and aid, as a fulcru the action of the deltoid in elevating the arm. (2) The section made within the capsule, after, of course, freely opening this, but damaging its attachments to the neck of the bone. (3) The tendon the bicipital groove is less likely to be interfered with. In every case excision, save the rare one for new growths, I would advise my read to begin by removing as little as possible, then plugging the wou with sterilised gauze to test the freedom in abduction, rotation, & of the humerus, and only to resort to further removal of bone if t mobility is much restricted.

The late Mr. Davies-Colley has related (*Guy's Hosp. Rep.*, thi series, vol. xx. p. 525) a case of partial resection followed unimpaired movement of the joint.

As, at the time of the operation, a portion of the head of the humerus seemed healt and the disease consisted chiefly of a carious erosion of the great tuberosity and adjacent portion of the articular surface, these portions only were removed, with dislocating the head of the bone. The part removed was chiefly the articular surf above the greater tuberosity, together with what remained of that process. The les tuberosity appears not to have been touched. About three-fifths of the articular surf was left, being healthy. There was some erosion of the bone below the epiphysial li but the greater part of the disease was situated in the epiphysis. The section of t bone was hard. Seven months later the movement of the joint was "perfect in eve direction. He swings the arm round above his head, and rotates it, and performs eve action with as great freedom and rapidity as with the left shoulder-joint."

If the disease extends lower down, gouging may be resorted to, or,

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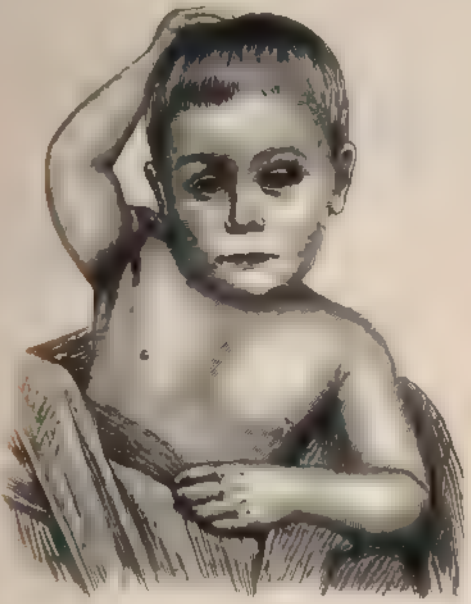
[*] Prof. Longmore (*loc. supra cit.*, p. 9) says that at one time there were at Fort P two patients, in each of whom resection of the joint had been performed, in one by t longitudinal, in the other by the flap incision. In the former case the patient co raise, without difficulty, ¾ hundredweight with the arm in an extended position by side, and hold 14 pounds in his hand when the arm was flexed. In the latter case, the movements of the joint were very seriously impaired. The man could not, in a degree whatever, move the arm from the side himself, nor could he flex the forearm up the upper arm without support from the other hand.

needful, one or two further sections* may be made till healthy tissue is reached, but, as in the case of the elbow, periosteal deposits or roughenings, which will subside when the irritation is removed, must not be mistaken for disease which calls for extirpation.

The glenoid cavity is then examined, and gouged if carious. Cases where its complete removal is called for must be most rare. If really called for, it may be effected by an osteotome, or by cutting bone-forceps, after the glenoid insertion of the capsule has been peeled off to a sufficiently high level; but taking away the glenoid cavity must interfere with the attachments of the biceps and triceps, and cause risk by the opening up of additional cancellous tissue.

Fig. 83



The above represents a fair average amount of movement, such as may be expected after excision in children, in whom the securing of adequate active and passive movement is always difficult. The disease was tubercular mischief in the upper epiphysis. Numerous sinuses were present in front and in the axilla.

The above operation must be somewhat modified in cases of ankylosis and new growths (pp. 151, 157). In cases of bony ankylosis the operator may adopt one of the two following courses: he may divide with a chisel or gouge the line of fusion, and then, the humerus being movable on the scapula, complete the operation on the lines already given; or, having sawn through the humerus *in situ*, he may seize the bone with lion-forceps, or drill a hole and insert McBurney's hook, and strip it out of its periosteo-capsular covering. Much care must be taken to put the humerus freely through its different movements before it is decided that sufficient bone has been removed,* lest ankylosis recur. I would refer my readers also to the remarks at p. 151.

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* In cases of gunshot injury, splinters of head or shaft may have to be carefully removed, and the point determined whether the shaft is extensively split towards the elbow. This is often very difficult to determine, because a longitudinally fractured shaft may be maintained in an apparently unfractured condition by the close apposition of the fragments, and by the periosteum, &c.

In those rare cases of resection of the upper end of the humerus for new growths (p. 157), the operation must be outside the periosteum, and the vessels and nerves will require additional attention. More room will be required now, and, to gain this, the pectoralis major and deltoid may each be detached from the clavicle. The shoulder-joint itself is very rarely invaded by the growth. Owing to the free removal of the humerus which is necessary, the after-result is often imperfect, though, if the insertion of the deltoid can be preserved, the limb will still be very useful.

Any vessels which require it, *e.g.*, branches of the circumflex arteries, are then secured, sinuses are laid open, pulpy tissue scraped out with sharp spoons, drainage provided, and the upper part of the wound closed. The drainage-tube should pass from the lowest part of the wound in front (whether this be within or below the capsule), by means of a counter-puncture, to the back of the upper arm, so that the site of the operation may be well drained while the patient is recumbent. In making the counter-puncture, from within outwards, the close contiguity of the circumflex vessels and nerve must be remembered.†

Where excision has been performed for tubercular disease, iodoform emulsion, and small tampons of iodoform gauze which has been kept in a solution of carbolic acid (1 in 20) or lysol (2 p.c.), will be employed, and the same will be made use of in cases where oozing is expected. The gauze thus used fulfils also the end of opening out the capsule, and encouraging, aseptically, the bone-producing property of the detached periosteum (Ollier). At other times, where the tissues are healthy, the above tampons will be much less needed, and the wound may be sutured in large part. A large pad of sterilised gauze, 4 or 5 inches thick at its base, should be placed in the axilla, and the arm carefully secured to the side, the elbow being kept a little forward, and comfortably kept away from the thorax by a sufficiently thick layer of salicylic wool. The first dressing should not be changed for five or six days, if possible, especially in children. While the fingers and elbow-joint must be gently exercised daily from the very first, the date of commencing movements of the shoulder-joint will depend on the lesion for which the operation was performed, and the condition of the parts around. Where these are healthy, when but little bone has been removed, where it is probable that new bone will be quickly reproduced, the date must be an early one. As a general rule it is of no use to begin before the deep parts of the wound are sufficiently healed; and this should be some time between the second and third weeks. The chief points to pay attention to are—(1) Care in carrying out abduction, lest the new head of the bone be lodged close to the coracoid process instead of in the glenoid cavity; (2) Massage and electricity to the muscles, especially the deltoid and the muscles attached to the tuberosities; (3) Exercise of the rotator muscles; (4) Making the patient

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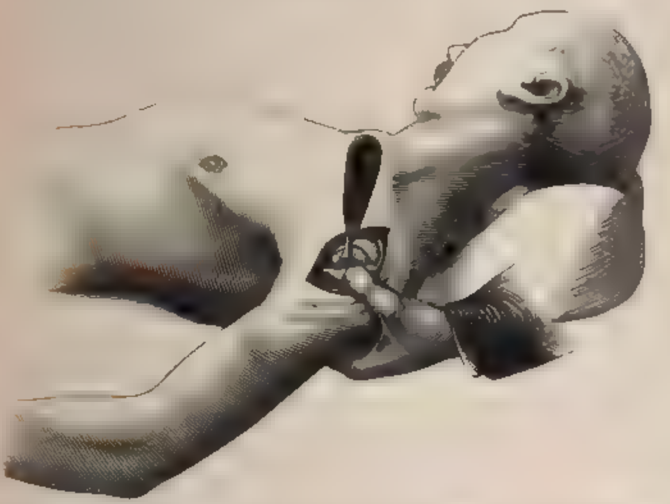
* In young subjects the epiphysial cartilage must be left undamaged, if possible.

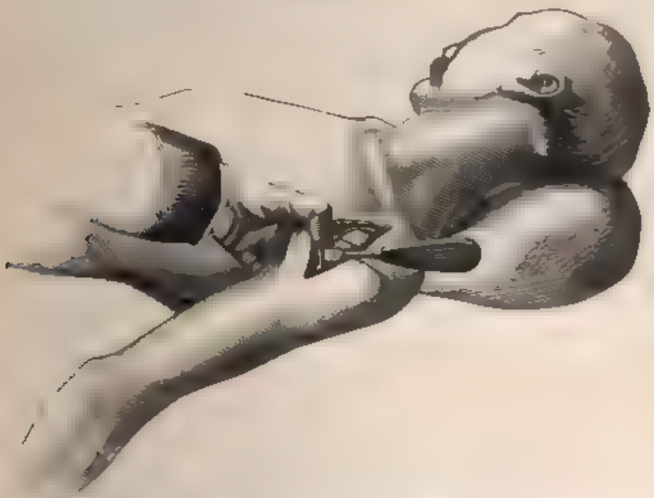
† At least two cases of fatal injury to the circumflex artery have been recorded. One is given by Gurlt (*Obs.* 175, p. 750), the other by Prof. Annandale (*Med. Times and Gaz.*, May 29, 1875). In the latter the incision which exposed the head of the bone divided the posterior circumflex artery so close to the main trunk that the operator was obliged to tie that vessel above and below the opening. Gangrene followed, necessitating amputation, and the patient, æt. 62, died.

FIG. 84



Separation of the periosteum from the great tuberosity, the arm being turned inwards. The blunt dissector is that of M. Farabeuf (Fig. 52). (Farabeuf.)

FIG. 85



Separation of the periosteum from the lesser tuberosity, the arm being turned outwards. (Farabeuf.)

carry out the movements of his humerus independently of those of the scapula—an end very difficult to ensure in the case of a child or in cases where ankylosis has long existed. The above must be daily and assiduously carried out, with the occasional aid of an anæsthetic if needful.

The practice of such movements as bringing a gun up to the shoulder, sweeping with a short brush, lifting and carrying light weights with the limb abducted, are valuable aids.

QUESTION OF SUBPERIOSTEAL RESECTION.—As one of the chief drawbacks of the operation is the poor amount of abduction and elevation which remains, owing, in large measure, to the humerus being too short to be brought into the glenoid cavity when the deltoid acts, I would urge very strongly that in this joint a trial of the subperiosteal method should be carefully made, to ensure as much reproduction of bone as possible. Von Langenbeck (*Arch. f. klin. Chir.*, 1874, vol. xvi.) gives more than one case in which the arm could be raised vertically, and the movements were excellent. While it is true that these were cases of resection for gunshot injury, and therefore the patients probably healthy adults, on the other hand preservation of the periosteum is not likely to be so easily effected here as in those cases where it is softened by disease. Even if the periosteum cannot be completely preserved, an additional half-inch or inch in length gained, and an irregular knob or nodule-like mass which may be moulded into a rudimentary head within the new capsule, may make much difference in the future mobility and usefulness of the limb.

M. Ollier (*loc. supra cit.*, t. i. p. 35, t. ii. p. 85) figures and describes a specimen of a resected humerus, nine years after the operation.

The patient, æt. 26, had had mischief in the joint for three years, with, latterly, suppuration and five fistulæ. Five centimetres of the humerus, measured from the summit of the head, were removed. After the operation he was able to follow his work as a hawker, and to use both arms equally well in lifting weights. The upper end of the humerus was irregularly expanded, showing numerous bosses and depressions into which the insertion of the capsule and different muscles could be followed.

AMOUNT OF BONE THAT MAY BE REMOVED.—This will mainly depend upon the amount of damage done to the periosteum, the possibility of retaining it entire, and the age of the patient.

Dr. Maclaren (*Lancet*, June 7, 1873) removed the head and 3½ inches of the upper end of the humerus with an excellent result.

Langenbeck mentions a case in which the whole shaft of the humerus necrosed.

This was removed, the elbow-joint being resected at the same time, and yet the reproduction of bone was so complete that the shortening was no more than 1⅝ inch. The patient was young, and growth went on, though the bone remained behind its fellow. The new humerus broke several times, but the movements of the shoulder and elbow were ultimately very satisfactory, and the hand was capable of most delicate movements.

Prof. Billroth (*Wien. Med. Blätt.*, March 20, 1884; *Lond. Med. Rev.*, 1884, p. 197) gives the case of a patient, aged 20, in whom the whole of the right humerus was removed when he was 12.

Though the periosteum was carefully left intact, the bone did not form again. Yet the forearm was well developed, and, by means of an ingenious splint and an artificial shoulder-joint, the patient could use his arm and hand well.

Excision of Shoulder in Military Surgery.—The following points of practical importance are taken mainly from the *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 519 *et seq.* While these statistics may appear unreliable, gathered before the era of antiseptic surgery, it is not improbable that in any great campaign, where large numbers of wounded have to be treated at short notice, surgical history will repeat itself. Dr. Otis here draws conclusions from the histories of 885 cases, 670 being for direct injury, and 215 for fractures in near proximity to the joint or for consecutive caries or necrosis.

Excision of the head of the humerus, together with portions of the clavicle and scapula—*e.g.*, acromion, spine, coracoid process, glenoid cavity—was performed in 42 cases.

It is remarkable that the mortality is less in this group than in that of simple removal. The following remarks are quoted from Lœffler:—Fracture of the glenoid cavity is especially frequent in shot injuries of the shoulder. This complication makes the prognosis of excision more serious, but is not a contraindication. If only fissures are present, the glenoid cavity should not be removed. Tedious burrowing of pus is very likely in these cases.

Partial excision of the head of the humerus was done in 14 cases.

The results do not prove that, when the head of the humerus is grooved or grazed by a ball, it is safer to slice off the injured part rather than to decapitate the bone. Ankylosis was too frequent to permit much to be said in favour of partial excision in this region.

Date of excision of shoulder.

The *primary* cases were 273, the *intermediate* 55 in number, the results being far less satisfactory than in the primary, "and corroborating the general rule forbidding operations during the inflammatory stage after injury, except under circumstances of exceptional urgency." The mortality was twice as great as in the primary, and nearly 12 per cent. greater than in the following. *Secondary*, 26 cases, with a mortality of 50 per cent. The greater success of primary excision can well be understood. The condition of the soft parts is much more favourable. There is no infiltration or burrowing of pus, no softening of parts or degeneration of muscles, no caries or osteitis—none, in fact, of those complications which, in secondary excision, imperil the life of the patient and usefulness of his limb.*

Excision of the head and portions of the shaft of the humerus as well was performed in 293 cases, in 190 of which the precise length of bone excised was specified.

Thus, in twenty-three, 4 inches; in eleven, 4½ inches; in seven, 5; in two, 5½; and in five, 7 or 8 inches were excised. While the arm was shortened (there being very rarely any restoration of bone) and feeble, the forearm and hand were usually most useful. Where the arm was flexile and uncontrollable, an auxiliary apparatus, such as the ingenious ones of Dr. Hudson (*loc. supra cit.*, Figs. 449, 453), brought about usually a great improvement.

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* Dr. Otis quotes Rupprecht, one of the German authorities in the war of 1871, to the same effect:—"The secondary operations were very much aggravated by deformities, gradually appearing after the injury, through thickening of the periosteum especially, and by extensive cavities succeeding abscesses. Immediately after the operation even, healing was retarded by pus-formations, sometimes under the clavicle, in other instances under the scapula, again on the anterior aspect of the arm. Aside from the greater muscular atrophy due to debility resulting from antecedent tedious suppurations, and to pain and loss of sleep; apart, also, from the abundant granulations attending secondary operations, and resulting prejudicially in regard to the future usefulness of the limb, the disadvantages of secondary operations already adduced were of sufficient importance to permit us to declare that primary resection of the shoulder-joint is preferable to the secondary operation."

Dr. Otis (*loc. supra cit.*, p. 611) states of shot-injury resections:—"In the majority of cases that I have examined, motion in flexion, extension, and adduction was tolerably well preserved. I have met with no instance of true ankylosis. In a large proportion of the cases, the functions of the forearm and hand were but slightly, and in many not at all, impaired. Those who argue that the limb is useless after an excision at the shoulder, because it dangles by the side, display a superficial appreciation of the considerations to be taken into account. Apart from the inestimable value of even a partial use of the hand, the mere weight of the limb, though its motor functions be completely destroyed, is of advantage in preserving the equilibrium of the body, and avoiding the distressing deformity consequent on ablation."

The following advice of Prof. Ollier as to the treatment of gunshot and other injuries of the shoulder-joint will be found most useful.

If the head only be fractured, and not in more than two or three fragments, and if these are held together and not widely separated, he would trust to antisepsis. If suppuration occurred, he would advise resection; and he points out that a deferred excision has one advantage—*i.e.*, that time may have elapsed for inflammation of the periosteum to have occurred, and thus its osteogenetic properties may be aroused. If the head of the humerus be badly shattered, and the fragments much separated from each other and from their periosteum, he would perform a primary excision, endeavouring to reshape the extremity into a new head. If the splintering and damage to the bone does not affect more than three or four centimetres of it, all the damaged bone may be resected; but if the mischief extends lower down, some risk must be run and the injured bone left. And his course would be the same in the case of a compound fracture of the neck of the humerus with dislocation. If part of the head had escaped splintering, he would leave this attached to the shaft. Removal of splinters Prof. Ollier directs to be done with the greatest care of the periosteum, every atom of this being left in the wound. While bullet-wounds may be used for drainage, it is rarely well to enlarge them or to throw one into another so as to employ them as the operation wound; this should be made in the usual place. With regard to the comparative value of primary and later excision, Prof. Ollier allows that bone-production is less likely in the former owing to the periosteum being uninflamed and more difficult to save. On the other hand, he points out that, as yet, we scarcely know what antiseptic precautions and the use of proper periosteal elevators will effect. Moreover, in primary resection for gunshot injuries the patients are usually young adults, and their muscles in excellent order.

In the case of gunshot and other injuries in which the damage is not limited to the head and surgical neck of the humerus, but splinters the upper half or three-quarters of the humerus, resection is still urged by Prof. Ollier (*vide supra*) as long as the soft parts are sufficiently sound to survive. Though the functions of a limb thus preserved will be very imperfect, the result will be far superior to that of amputation at the shoulder-joint. In any such resection the antiseptic precautions should be as complete as possible, and any long splinters, which, however much the bone be shattered, preserve their relation to the periosteum, should be left, as, with the aid of the bone-production of the periosteum around them, they will maintain the continuity of the bony column.

SURGICAL INTERFERENCE IN SEPARATION OF THE UPPER EPIPHYSIS OF THE HUMERUS.

This is often a difficult lesion to treat. Under certain circumstances, operative interference, with the safety that antiseptic precautions duly carried out give nowadays, should be resorted to. We may divide the cases that call for it into the following groups:—A. **Cases of Simple Injury.** B. **Cases of Compound Injury.**

A. **Simple.**—These may be further divided into—i. **Those of recent date.** ii. **Those of longer standing.**

i. **Simple Cases of Separation of the Epiphysis of recent date.**—Here interference is justified when there is very great difficulty in effecting reduction owing to complete separation of the two parts, aided by the rotation of the epiphysis and the very small size of the upper fragment. Mr. Poland, in his *Traumatic Separation of Epiphyses* (p. 226)—one of the most striking works on surgery which have ever appeared in any language, and a mine of wealth as far as its lucid, complete, and helpful instruction goes—states that "one of the chief difficulties in reduction occurs from the insertion between the epiphysial fragments of bands of periosteum, fascia or muscle, or from the penetration of the periosteal sheath by the diaphysial end." Other cases are those where, if the displacement is corrected, there is much difficulty in maintaining the reduction when a sharp portion of the lower fragment, having penetrated the deltoid, is projecting under the skin, and when there is evidence of pressure on the vessels and nerves.

The **operation** should be performed on some such lines as these. An incision is made freely in the interval between the pectoral and deltoid; the cephalic vein is drawn aside or tied between double ligatures. The soft parts having been widely retracted, the ends of the two fragments are next identified and examined, any rent in the periosteum being carefully enlarged if needful. It will now be found possible, in some cases, to replace the fragments in position, and that they will remain in position after any folded-in fibres of muscle or periosteum have been removed. The edges of the rent in the periosteum and capsule should be carefully sutured, and it may be well to draw together with buried sutures of sterilised chromic gut any opened-up periarticular planes of connective tissue. Where the fragments do not come readily into position, it will be needful to remove any projection from the lower fragment. If there is any difficulty in retaining the fragments in position it will be well to wire them together, the wire being hammered down *in situ* or left long for subsequent removal (p. 100). The question of the use of drainage will depend upon the degree of disturbance of the parts, the amount of probable oozing, &c.

In those cases where the epiphysial head is not only separated, but dislocated owing to the severity of the injury having lacerated the capsule freely, Poland (*loc. supra cit.*, p. 243) advises as follows:—

"Seeing that it is almost impossible to reduce the head of the bone in these extremely rare cases, an incision should be made, with antiseptic precautions, through the skin and deltoid down to the seat of separation, and the epiphysis replaced in position. It will be found necessary to open the capsule of the shoulder-joint before the epiphysis can be reduced. This should be accomplished by direct manipulation of the head into its place by pressure of the thumb and fingers, or by means of a traction-hook (Fig. 79) inserted into a hole drilled in it after the method advocated by McBurney (*Ann. of Surg.*, April 1894, p. 408). The fragments should then be fastened together in their normal position by means of pegs or sutures."

ii. **Cases of older date.**—Here, where some weeks or months have elapsed, interference may be called for, owing to the limitation of movement, especially as regards abduction, elevation, and rotation, brought about by the overlapping of the fragments, their union in a faulty position, and the projecting callus. Here, after exposure of the seat of union, and free retraction of the soft parts, the surgeon will have to follow the advice of M. C. Walther (*Rev. d'Orthop.*, Jan. 1897, p. 43, quoted by Poland, *loc. supra cit.*, p. 240), and decide between the necessity of completely resecting the callus in order to place the fragments absolutely in position, or to freely remove any projecting ends of the diaphysial fragment, and plane away any excessive callus.

B. **Compound Cases.**—Here resection of the projecting end of the diaphysis will usually be required before reduction can be effected, a step that will facilitate the thorough cleansing of the parts which is so much required. Wiring with sufficiently stout wire, and suture of the rent in the periosteum, will be required, as already indicated at p. 169. About three weeks after any of these operations, passive movement should be begun, and perseveringly continued, together with friction and massage.

CHAPTER VII.

REMOVAL OF THE SCAPULA.

Indications.

1. New growths. 2. Caries. 3. Accidents—*e.g.*, railway and machinery accidents.

1. As it is the first of the above which chiefly raise the question of removal of the bone, and which present the greatest difficulties, it is to removal of the scapula for new growths that most of the following remarks will apply.

A. **Partial Removal of the Scapula.**—In a very few cases (*e.g.*, where the surgeon, operating on an exostosis, is uncertain as to the nature of its base and does not feel satisfied with gouging this, or where he is certain that he is dealing with an unmixed enchondroma in an early stage) this may be sufficient. The chief essential points here are —(1) to freely expose the growth by appropriate flaps, so that the limits may be clearly defined; (2) to be provided with reliable instruments of keen temper, owing to the exceeding hardness which may be met with here.

While some Continental writers[*] have given elaborate directions for partial removal of the scapula, it is only in the above very few cases that this operation is likely to be used by English surgeons. Mr. Pollock, in his paper[†] on two cases of removal of the scapula, thus advises on this matter: "If a portion of the scapula be removed, it should only be the lower portion. But even if this be attempted, the loss of blood would probably be much greater than if the whole bone were removed; for the wound is more confined, and the wounded arteries are more apt to retract behind the bone above, and offer great obstacles to their being secured. However, should the lower angle be alone the seat of disease, the attempt to remove the lower portion only is justifiable." It must, however, be borne in mind that, when a bone is once the seat of disease which requires removal, the disease is very apt to recur in the portion left, and less liable to do so if the whole bone be removed.

The above remarks of Mr. Pollock are entirely borne out by the histories of cases which have been watched after partial removal of the scapula for any growth save an exostosis.

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[*] *E.g.*, M. A. Demandre, *Des Tumeurs de l'Omoplate* (Paris. 1873).

[†] *St. George's Hosp. Rep.*, vol. iv. p. 236.

Thus, in January 1865, Sir W. Fergusson (*Lancet*, vol. ii. 1865. p. 591) removed the lower two-thirds of the scapula for a sarcomatous growth. Recurrence took place, and, in the following November the rest of the scapula, the greater part of the clavicle, and the upper extremity were taken away.

Dr. Bird, of Stockport (*Lancet*, vol. ii. 1865, p. 696), removed the lower two-thirds of the scapula for a growth the size of an orange in the infra-spinous fossa, in a child aged 10, the bone being sawn through behind the neck in a line with the supra-scapular notch. A year and a half later the growth recurred and grew quickly, the rest of the scapula being now taken away together with the head of the humerus, which had become adherent to the scapula, and thus also required removal. A year and a half later the child remained well, the use of the hand "in sewing and writing being very little impaired."

B. **Removal of the Entire Scapula by itself** (*e.g.*, cases where the growth is primary from the scapula, and where there is no extension to the humerus or into the axilla).—Preparations against shock should be taken, the extremities being bandaged in cotton-wool, the head kept low, ether given, and subcutaneous injections of ether and brandy, and the materials needful for injection of saline solution (p. 107) being in readiness. The patient is placed at the edge of the table and rolled over to the opposite side. If the growth is very vascular, or the patient weakly, pressure on the subclavian, if effectual, may help; or if, from the extension of the growth, this is rendered difficult, it may be effected by making an incision down to and through the deep fascia over the artery itself, in order to enable an assistant to put his thumb or finger directly upon it.* This may be done by a separate incision, or by an extension of that by which the clavicle is divided. But as the movements of the limb may easily dislodge the assistant's finger, the operator will do better to trust to plenty of Spencer Wells's forceps, and tying these off in batches of four or five.

Flaps are quickly and freely turned back, usually by a T-shaped incision, one limb running from the acromio-clavicular joint inwards to the superior angle of the scapula, while the other and longer is made at right angles to the first down to the angle of the scapula. In another case the surgeon may prefer to make an incision along the vertebral border of the scapula, and the other at right angles to it across the centre of the growth.† In either case care must be taken not to open the capsule of the tumour.

When the whole mass is thoroughly exposed, the trapezius and deltoid are first severed, the arm being pulled away from the trunk. The levator anguli and the rhomboidei are next cut through,‡ the posterior scapular artery secured, and the serratus magnus divided, being first made tense by lifting the scapula off the ribs upwards and outwards. The muscles on the upper border are now* attacked—viz., any remains of the deltoid, the omo-hyoid, and the supra-spinatus—and the supra-scapular artery secured. The acromio-clavicular joint is next opened, or else the acromion or clavicle,† according to the extension of the growth in this direction, severed by bone-forceps or a narrow saw. If the acromion can be safely left, the resulting deformity—viz., dropping of the shoulder and entire loss of the action of the trapezius—will be lessened.

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* As adopted by Prof. Syme in performing the old operation in a case of axillary aneurysm, p. 134. If the clavicle is going to be removed, the subclavian can be commanded by cutting down on the clavicle, freeing it from its attachments in its inner third, passing a flat director carefully beneath it, sawing through the bone here, and removing a portion of it, the finger being thus placed directly on the subclavian (Jeaffreson, *Lancet*, 1874, vol. i. p. 759).

† If the skin is involved or ulcerated, the flaps must be so shaped as to isolate this.

‡ It is a bad sign if any of the muscles severed are infiltrated with growth. That this, however, is not incompatible with a good recovery is shown by the second of Prof. Syme's cases (*Excision of the Scapula*, p. 28), in which it is stated that "the tumour weighed between 4 and 5 pounds; it had a soft consistence and very suspicious aspect, which was strengthened by microscopical examination, as the muscular substance that was taken away along with the growth appeared to be loaded with the germs of future disease; but fifteen months having elapsed since the operation was performed, without the slightest

The lower angle being freed and the latissimus dorsi (if involved) resected, the scapula can now be dragged away from the chest by slipping two or three fingers over the upper or vertebral border. Thus, by tilting the scapula outwards, the axillary border can be inspected, the teres and infra-spinatus muscles severed, the position of the subscapular artery defined by a finger passed beneath it, and this vessel secured, if possible, before it is cut. This part of the operation should be performed with careful deliberation. The scapula being still further pulled away from the chest, the muscles attached to the coracoid process are next severed, and the scapula removed by cutting into the shoulder-joint and severing the capsular tendons and the biceps and triceps. The coracoid process may become detached at this stage if partially eroded by extension of the growth, or if the patient be young. If this happen, it must be carefully dissected out afterwards.‡ The main arteries must be secured before they are cut. Too many Spencer Wells's forceps must not be left on at one time, or they will be found to interfere with the needful manipulation of the bone. Every vessel must be thoroughly secured by

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appearance of relapse, it may be hoped that the recovery will prove permanent." On this point I would refer my readers to the case of mine at p. 176.

* If the upper border can be taken before the axillary one is dealt with, the subclavian can be better controlled when the subscapular artery (a source of free hæmorrhage) is severed.

† Prof. Spence (*Edin. Med. Journ.*, Aug. 1872, p. 178) recommends that the clavicle should be left, not sawn through, otherwise the head of the humerus tends to project through the incision, there being nothing but skin left, the overhanging arch of bone having been removed. On the other hand, sawing the clavicle, while it leaves a cut surface of bone as a possible source of irritation, facilitates the operation somewhat, as it exposes better the large vessels and the muscles attached to the coracoid process.

‡ If the growth has involved the axillary vessels and nerves, this outlying portion may be dealt with later on, after the main mass has been separated and removed. If it is desired to remove this extension of the disease now while in continuity with the scapular growth itself, the surgeon will have both his hands free for what is a troublesome dissection, by asking an assistant to drag the main mass strongly backwards. To facilitate this step, Prof. Syme (*loc. supra cit.*, p. 26) placed a piece of cord round the divided extremity of the clavicle, for the assistant to pull upon. The greatest care must be taken, when dealing with projections into the axilla, to keep the knife, or blunt dissector, as close as is safe to the growth, for fear of opening the large vessels. But it will be well, in cases where there is evidence of the scapular growth having encroached upon the large vessels and nerves, to obtain leave for the performance of interscapulo-thoracic amputation. The first step in the operation should now be division and sufficient removal of the clavicle, so as to clear up the state of the above important structures. If they are involved by the growth the major operation (p. 177) should be at once resorted to.

ligature; otherwise, oozing is very likely to take place a few hours later.*

Hæmorrhage may be best avoided by attention to the following points:—(1) A trial of adequate pressure on the subclavian, this being effected by a special incision, if needful, to command the vessel. Reasons for not trusting to this have been given at p. 139. (2) Dealing with the axillary border and subscapular artery last. (3) Making use of Mr. Watson Cheyne's method, and securing the axillary artery early. (4) Rapid use of knife or scissors by the operator, aided by intelligent help from assistants in securing bleeding points, and from an anæsthetist who will not be unduly anxious. (5) Taking care not to cut into the growth itself. (6) By some it is recommended to make the incisions gradually, not larger than are required at the time, as a means of minimising the hæmorrhage. It must be remembered, with regard to this point, that small and cramped incisions interfere with a free and rapid hand and sufficient exposure of the parts, conditions which conduce to thorough dealing with bleeding points, and thus facing one of the chief difficulties of this important operation.

Adequate drainage is now provided, the flaps united, and the arm secured to the side for a few days, after which it may be supported in a sling if the head of the humerus does not tend to protrude.

Mr. Watson Cheyne has made use of an anterior incision in removal of the scapula for a large enchondroma which filled up the axilla, "projecting the pectoralis forwards to a marked degree," an incision which he recommends in all cases (*King's College Hosp. Rep.*, vol. ii. p. 83; *Clin. Soc. Trans.*, 1895, vol. xxviii. p. 284). In the first instance an incision was made along the lower border of the pectoralis major, opening the axilla freely. The axillary vessels and nerves were then freed from all connection with the tumour throughout their whole extent. The subscapular artery was then found and tied, and the pectoralis minor and other muscles attached to the coracoid process were divided. "The patient was then turned over, and the operation was completed in the ordinary way. . . . The ligature of the subscapular artery answered admirably. In this case the patient lost extremely little blood, probably not more than an ounce altogether. The detachment of the muscles attached to the coracoid process also enabled the operation to be completed very rapidly, for after the posterior scapular muscles had been divided, and the trapezius and the deltoid had been raised, the acromioclavicular joint and the muscles going to the head of the humerus were practically the only things which had to be divided."

In the case of sarcomata, removal of the scapula alone or together with the upper extremity (chap. viii.) may be called for.

The malignancy of these growths is well known, together with their tendency to involve surrounding parts and to creep into regions inaccessible to the surgeon. Early operation is imperatively required.

In the case of operation, the prognosis will be best, however large the growth, when the rate of progress has been slow, when the growth is uniformly hard, or if only a certain amount of elasticity is combined with the hardness (as in unmixed enchondromata), when the outline is distinct and well defined, and the mass movable upon the ribs.*

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* In a case of this kind, Mr. Berkeley Hill transfused twice, but unsuccessfully, the patient dying of shock and acute septicæmia in forty-five hours (*Brit. Med. Journ.*, 1880, vol. i. p. 487).

On the other hand, the prognosis is less favourable when the outline is uniform rather than nodulated or bossed, the feel semi-elastic instead of hard, the progress rapid and painful, the different parts of the scapula much obscured† and its mobility much impaired, the outline of the growth ill defined and lost indistinctly in the axilla. Pulsation, bruit, enlarged glands, infiltration of the skin, and any local rise in temperature are also of evil omen. In these cases when the prognosis is unfavourable the surgeon will do well to resort to interscapulo-thoracic amputation (p. 177).

CONDITION OF THE LIMB AFTER REMOVAL OF THE SCAPULA.—A limb thus preserved will be strong and useful. If the clavicle has not been much interfered with, the clavicular fibres of the deltoid will remain, and these, together with the latissimus dorsi and pectoralis major, will probably confer a fair amount of motion on the limb. In one of Prof. Syme's cases, after removal of the scapula and the outer third of the clavicle, and, by a previous operation, the head of the humerus, the patient was able to lift heavy weights, and to fill the appointment of provincial letter-carrier.

In a very successful case of Mr. Symonds' (*Clin. Soc. Trans.*, vol. xx. p. 24), in which the scapula was removed for osteo-sarcoma, the man was in good health two years and a half after the operation.

He was able to do all the lighter work of a carpenter, including the use of a plane. Overhead work he could not do. In this case the articular surface of the humerus had also been removed about a month later, as it was thought to be the cause of prolonged suppuration.

The following case is of interest from the extension of the sarcoma into one of the scapular muscles, the ill-defined outline and soft feel of the growth, its long duration, and yet the long period of relief which has followed:

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[*] That this mobility is a matter of some importance is shown by the following case, quoted by M. Sédillot at p. 550 of his *Traité de Médecine opératoire*: "Nous refusâmes un jour d'opérer un jeune homme atteint d'un cancer énorme du scapulum, dont les limites n'étaient pas nettement fixées, et nous dûmes nous applaudir de notre abstention en decouvrant plus tard, à la nécropsie, que la tumeur avait pénétré dans la poitrine et envahi un lobe pulmonaire." Mr. A. Marmaduke Sheild has kindly drawn my attention to an important case which shows how easily a sarcoma of the venter scapulæ may implicate the thorax, without any exact diagnosis of the position and extent of the growth being possible. A boy, æt. 10, was admitted under his care with a swelling, the size of an orange, on the axillary border of one scapula. This swelling was somewhat fixed, moving but slightly when the arm and scapula were raised at the operation. The intercostals and pleura were found to be blended with the growth. In the attempts to separate them the pleural sac was opened. Pneumothorax ensued, and death took place the next day. The specimen which illustrates this instructive case will be found in the Hunterian collection, R.C.S., No. 586B.

[†] In a very large scapular sarcoma on which Mr. Pollock operated, it is stated that "the mass extended over the upper portion of the scapula, which could not here be traced, and over the outer part of the clavicle, which could not be felt; and also so far into the lower triangle of the neck that the subclavian artery could not be distinguished or reached by the finger." The whole mass was removed, but the patient, aged 47, died on the sixth day, of chronic bronchitis.

In March 1892 one of the nurses at the Canterbury Hospital was sent to me by Dr. Alexander, of Faversham. The outline of the left scapula was replaced by a large mass, of uniform outline, fairly defined over the lower two-thirds of the bone, but above very indistinct, semi-elastic to the feel, without any nodules or bosses of harder growth. The scapula was movable upon the ribs. The history was one of early pain eight months before, for which the patient used to resort to the baneful remedy of rubbing her scapular region against any hard projecting ridge, *e.g.*, a mantelpiece. For the last three months the increase in the size of the swelling and in the pain had, alike, been rapid. The scapula was removed in Bright Ward, Guy's Hospital, and I am particularly indebted to Dr. H. Hodgson, now of Blisworth, for the masterly way in which he administered the ether. The most interesting point about the case was that the sarcoma, which appeared to have begun in the infra-spinous fossa, had perforated the bone, and in many places greyish masses of growth could be seen blending with and replacing the delicate fasciculi of the subscapularis. The chief difficulty met with in the after-treatment was keeping the patient, a highly neurotic woman, and one not amenable to treatment, quiet. The wound did not run an aseptic course. Ten days later, incisions were required for drainage of the suppuration which followed. Later on, the articular surface and epiphyses of the head and tuberosities of the humerus became detached. Two years after the operation I saw the patient. The antero-posterior movements of the shoulder-joint were good. The patient could nurse a delicate mother, use her needle, &c., but abduction and elevation were almost completely abolished. In spite of the infiltration of one at least of the muscles, there was no evidence whatever of any recurrence.

Age of the Patient.—It may be not uninteresting to some to know that the scapula has been successfully removed for growth at ages varying between "about seventy" and "about eight." The former was a patient of Prof. Syme, who died about two months after the operation, apparently of internal deposits. The latter case occurred in India,* the upper extremity being removed at the same time.

Dangers of the Operation and Causes of Death.—These will be the same as those given at the end of the next chapter.

2. Removal of the Scapula for Caries.†—This needs no especial mention. The parts being sufficiently exposed, the operation will be conducted, as far as possible, subperiosteally, by means of appropriate blunt dissectors or periosteal elevators.

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* A very brief mention of this case is given in a letter, *Lancet*, 1874, vol. i. p. 819. It is not stated whether the patient was a native or no.

† A good case of this kind is recorded by Sir W. Fergusson (*Med.-Chir. Trans.*, vol. xxxi. p. 310). An exquisite drawing of the scapula—one of the very best by the hands of the Baggs—will be found in the same author's *Practical Surgery*, 4th ed. p. 309, Fig. 144.

CHAPTER VIII.

REMOVAL OF THE UPPER EXTREMITY, ARM, SCAPULA, AND GREATER PART OF THE CLAVICLE.

INTERSCAPULO-THORACIC AMPUTATION.

THIS operation, performed chiefly for growths of the humerus which cannot be completely removed by amputation at the shoulder-joint,* occasionally for growths of the scapula (p. 175) and those of the axilla, as in Mr. Stanley Boyd's case (p. 181), and, much more rarely, for injury, has been of late years advocated by M. Paul Berger (*L'Amputation du Membre supérieur dans la contiguité du Tronc*, Paris, 1887) amongst Continental surgeons, and by Mr. Treves and others in this country and America.

The method described below is that of M. Berger; a very clear account is also given by M. Farabeuf (*loc. supra cit.*), and one by Mr. Treves (*Oper. Surgery*, vol. i. p. 397): on these I have drawn largely.

First Step.—Division of the clavicle and securing the vessels. The patient being brought to the edge of the table, with his shoulders raised, the surgeon, standing outside the limb, makes an incision with a stout scalpel along the whole length of the clavicle, from just outside the sterno-mastoid muscle to a point immediately beyond the acromio-clavicular joint. The incision divides the periosteum down to the bone over the middle portion of the clavicle. At this stage venous oozing from the large superficial veins here met with may be very free. With a curved elevator (Fig. 52) the periosteum is separated from the middle portion of the clavicle.† A large blunt hook (Treves) or a blunt dissector being passed under the inner end of the bared part of the clavicle, this is sawn through with a narrow or chain-saw. The same part of the clavicle being now raised and steadied with lion-forceps, and the periosteum completely separated from its under surface, the bone is again divided at the outer end of its middle third. If resection of part of the clavicle is performed, the removal of bone must be free enough to facilitate the finding of the subclavian vessels. Limited removal of bone will much increase the difficulties of the above step (pp. 179 and 181). The tendency of the upper extremity to fall outwards after division ot the clavicle will increase the space between the two parts of this bone. The exposed subclavius with its sheath is now isolated and cut through close to the site of the inner section of the clavicle, dissected up so as to expose the large vessels, and turned outwards.* Fasciæ of varying thickness will have to be divided before the vessels are reached (Treves). During this step the upper border of the pectoralis minor should, if possible, be defined; the surgeon must be prepared for troublesome bleeding from the cephalic vein and branches of the acromio-thoracic vessels, and he may find a guide recommended by Berger—viz., the external anterior thoracic nerve—easy to see or feel. This nerve, if followed upwards, leads to the interval between the artery and vein.† These large vessels are then secured and divided between double ligatures of carefully sterilised silk, pushed well apart in each case, and tied very securely before each vessel is cut. The ligatures should be placed upon the subclavian vessels themselves, at a point to which the tubercle on the first rib will be a guide. If possible the artery should be secured first, and the arm well raised while the ligatures are placed around the vein, so that as little blood as possible be left in the extremity. Tying the artery first will lessen the size of the vein and render the securing of it less difficult; furthermore, as pointed out by Prof. Keen, if the vein be injured, as happened in his case, while it is being tied, the wound will not be flooded with blood. If, however, the vein be so much distended as to obscure the artery, the former vessel must be taken first. In either case the greatest care must be exercised not to injure this vessel for fear of air entering the circulation. If any such accident occur, the spot must be instantly closed, and the wound flooded with some weak aseptic lotion. While exposing the vessels, the suprascapular vessels will probably be seen crossing the upper part of the wound, and should be secured. The nerve-cords should be cut square and as high up as possible. Mr. Stanley Boyd, in his case (*infra*, p. 181), finding that removal of the middle third of the clavicle was insufficient to permit of easy ligature of the vein, which lay beneath the inner third, removed another inch from the bone. He also found that division of most of the brachial plexus facilitated ligature of the artery, the plexus at once starting into relief on division of the clavicle.

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* As in Mr. Barling's case (p. 182), any surgeon in doubt as to the necessity of submitting his patient to so severe an operation, should begin by an incision between the deltoid and pectoralis major, and then, when the muscles are thoroughly retracted, examine the condition of the axilla, the glands, and determine whether the large vessels and nerves are embedded in the growth, &c. In other cases, division and partial removal of the clavicle may be required in order to clear up the doubtful point.

† This preliminary detachment of the periosteum was recommended by Prof. Ollier as a safeguard against wounding the vessels. Mr. Chavasse (*loc. infra cit.*) says that "practically this step is not to be recommended, as the periosteum left obscures the subclavius muscle, and has to be immediately divided." I should further object to it, in cases where the operation is performed for the removal of malignant disease, as likely to favour recurrence of the growth.

Dr. Le Conte, of Philadelphia (*Annals of Surgery*, Sept. 1899), recommends disarticulation of the sternal end of the clavicle as preferable to resection. In the latter the large vessels are exposed in a narrow field and at a considerable depth. Disarticulation he believes to be simpler, quicker, and safer, by its giving a much fuller exposure of the vessels.[*] The incision is begun over the sternal end of the clavicle, carried to about its middle, and then curved downwards to the anterior axillary fold. The skin and superficial fascia are dissected up, exposing well the inner two-thirds of the clavicle. This bone is then disarticulated by severing its attachments to the sternum and rhomboid ligament, the clavicular part of the sterno-mastoid and pectoralis major. The clavicle is now pulled upwards and outwards, and the subclavius stripped off or divided. The pectoralis minor is now seen and divided, and the vessels thus well exposed.[†]

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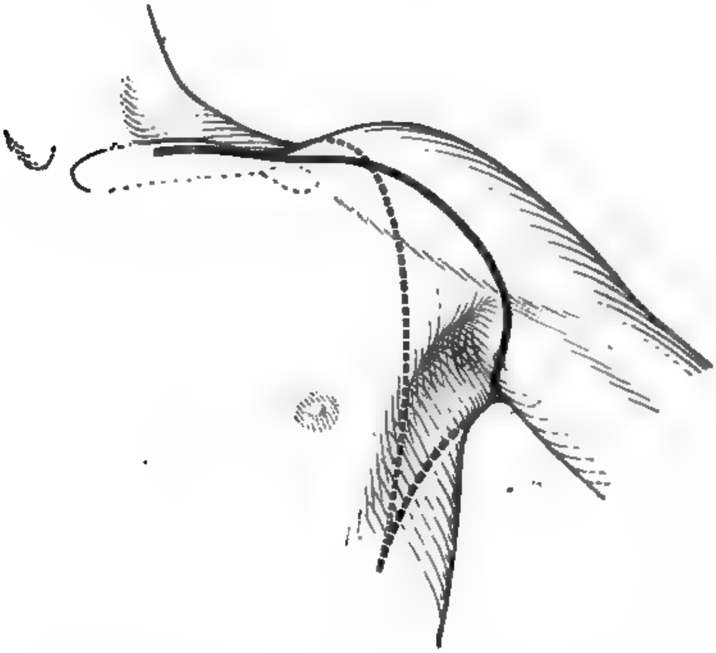
* The subclavius must be thoroughly divided in order to obtain room for securing the vein.

† Careful feeling for the pulsation of the artery will be another aid.

Second Stage.—Formation of the flaps. These are pectoro-axillary and cervico-scapular, and, in fashioning them, the surgeon must be guided by the extent of the disease. The patient being so placed and steadied that the whole of the scapular region is free of the table, and the surgeon standing between the limb and the trunk, the pectoro-axillary flap is then traced as in Figs. 86 and 87. As there shown, it commences in the centre of the incision over the clavicle, runs downwards and outwards just above the coracoid process, and then parallel with, but a little external to, the depression between the

FIG. 86.



Interscapulo-thoracic amputation. Outline of the flaps (left side). The posterior or cervico-scapular flap is shown dotted. (Farabeuf.)

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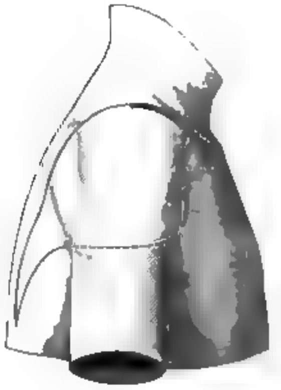
[*] In addition to the cases I have mentioned in the footnote, p. 181, in all of which much difficulty was met with in securing the large vessels, Dr. Le Conte mentions three others in which the same trouble occurred. The operators were von Langenbeck (*Arch. f. klin. Chir.*, 1862, Bd. iii. s. 340) and Ollier (*Lyon Médical*, Feb. 1885, t. xviii. p. 158).

[†] Dr. Le Conte also points out that complete removal of the bone is safer in cases of growth [illegible] the sternal end.

deltoid and the pectoralis major. On reaching the point where the anterior wall of the axilla and the arm join, the knife is carried over the lower edge of the pectoralis major across the axillary aspect of the arm (Fig. 86), and then backwards and downwards (the limb being well raised by an assistant) so as to pass over the lower edges of the latissimus dorsi and teres major and end over the apex of the scapula (Fig. 87). The above incision only divides skin and fasciæ. The pectoralis major is next cut, and the pectoralis minor found and severed near the coracoid process. The top of the axilla being now well opened up, the cords of the plexus are divided at the same level as the large vessels, great care being taken of the central ligatures on these, the patient being rolled over on to his sound side, and the limb drawn across the chest. The cervico-dorsal flap is next made by drawing the knife from the outer extremity of the clavicular incision, straight back over the spine of the scapula to the lower angle of this bone, where it meets the first incision. The skin and fascia divided by this incision are reflected to the vertebral border of the scapula.*

Fig. 87.



Interscapulo-thoracic amputation (right side). (Keen.)

Nothing now remains but the *third and last stage*—viz., the removal of the limb. This is effected by the division of the trapezius, omohyoid, latissimus dorsi, levator anguli, rhomboids, and serratus magnus. While these muscles are severed the flaps are well held back, and the limb suitably manipulated, partly by an assistant and partly by the left hand of the operator.† During this stage the posterior scapular and the supra-scapular may or may not require ligatures, according as they spring from the first or the third part of the subclavian, in the latter case being on the distal side of the ligature (Spencer). But of course the mere mention of normal arteries gives no idea of the number of both veins and arteries that will be met with, enlarged, in cases of new growths. This makes it all the more important to secure first the subclavian artery and vein.

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* In a case of cystic lympho-sarcoma, in which the growth covered the shoulder and extensively involved the skin of the posterior triangle, Mr. Spencer (*Clin. Soc. Trans.*, vol. xxviii. p. 165) was obliged to take skin from the arm by the following incisions. The anterior flap was marked out by an incision reaching from the level of the angle of the jaw to the junction between the second rib and the sternum, and passing thence over the lowest part of the growth to the anterior fold of the axilla. The posterior flap was marked out by starting from the upper end of the anterior incision, across the back of the growth, along the upper border of the scapula, over the point of the shoulder, to meet the first incision again at the anterior axillary fold. The flap was next raised from the upper half of the arm by a vertical incision down the inner side, and a horizontal one round the middle below the insertion of the deltoid. This flap, though deriving its blood-supply only from the posterior cervical and dorsal vessels through the skin of the axilla and posterior axillary fold, lived well. In this case the axillary vessels were secured after the anterior flap was reflected.

† The humerus, if much invaded by growth, may, here, give way.

The flaps and all the recesses of the large wound are most carefully scrutinised for any evidence of infiltration or extension of new growth. The muscles, especially the pectorals (Stanley Boyd), should be cut short to avoid any possibility of infiltration. The condition of the glands in the posterior triangle should also be investigated.

Mr. Stanley Boyd, in the discussion at the Clinical Society on Mr. Barling's cases (*infra*, p. 182), related the following instructive case.

Five weeks previously a man, æt. 25, had come under his care at the Charing Cross Hospital for sarcoma of the axilla, which had attained the size of two fists in three months. It was not fixed to bone, but was closely attached to some soft parts. There was no evidence of pressure on the great vessels or nerves, of involvement of the supraclavicular glands, or of secondary growths in the viscera, &c. Operation proved that the great vessels and nerves were so surrounded by growth that only an interscapulo-thoracic amputation would remove the disease. As consent had not been obtained, nothing further was done then. Four weeks later the mass round the vessels had increased considerably, and amputation was performed on Berger's lines, with certain improvements in two or three details, which have been mentioned above. The patient, at the time of the report, was making an excellent recovery.

Dangers of the Operation and Causes of Death.—These are:

1. Hæmorrhage.*—This may be met with from the main trunk, the scapular branches of the subclavian, the branches of the axillary, and the enlarged anastomosing veins in cases of growth. The first two of these dangers, and the third, to a larger extent, will be met by tying the subclavian vessels after Berger's method. This also prevents entrance of air into the large veins, allows of section of vascular muscles like the great pectoral with scarcely any bleeding, while division of the posterior muscles, where the arterial supply has not been cut off, is reserved for the last step of the operation. If, after resection of the clavicle, it is found impossible to secure the third part of the subclavian vessels owing to the profuse venous oozing, or to the displacement of the parts from invasion by the growth, Mr. Chavasse advises proceeding at once to make the upper part of the anterior flap, dividing the two pectoral muscles, and, after fully exposing the first part of the axillary vessels, tracing these up to the scalenus anticus and tying the subclavian artery and vein. Other courses open are to tie the subclavian vessels

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* Control of this is the key to the situation. The following cases show what difficulties may be met with in meeting it. Mr. Macnamara (*Lancet*, vol. i. 1878, p. 669), after resecting part of the clavicle, was unable to find the artery owing to the large veins exposed. The hæmorrhage was very great, and the patient died on the following day. A portion of growth was found to have passed upwards behind the scalenus muscle. Mr. Chavasse, in his case (*Med.-Chir. Trans.*, vol. lxxiii. p. 81), being unable, owing to free venous oozing, to tie the subclavian vessels, divided the first part of the axillary vessels between double ligatures. Profuse arterial hæmorrhage followed, on the seventeenth day, from the lower part of the wound, which was granulating (it is not stated whether the healing had been aseptic throughout). The second part of the subclavian artery was tied, and the patient made an excellent recovery. Prof. Keen (*Amer. Journ. Med. Sci.*, June 1894) met with great trouble in securing the subclavian vein. "A large vein under the inner sawn end of the clavicle tore, and gave me much trouble, but finally, partly by a ligature round the tissues in which lay the vein, and partly by a ligature which was applied temporarily round the tissues and around the sawn end of the clavicle in a groove sawed in the bone, so as to prevent the slipping of the ligature. I was able to control it." Another most instructive case is given by Prof. Keen, *Annals of Surgery*, June 1895.

in their third part in the usual way. Dr. Joseph Bell (*Man. of Surg. Operations*, sixth ed.) secured the hæmorrhage by a "skewer" passed under the clavicle and vessels, and a rubber cord looped round.

2. Shock.—This will be met by taking every step to prevent hæmorrhage, emptying the limb of venous blood before the vein is tied, keeping the body warm, administering ether, and completing the operation as speedily as possible. Afterwards, infusion of saline fluid (p. 104) should be resorted to, if other methods—*e.g.*, subcutaneous injection of strychnine, ether or brandy, enemata of port wine and beef-tea, and bandaging of the other limbs—are insufficient.

3. Septicæmia.—This is a very probable danger, if the flaps (perhaps left needlessly full) slough, or if retention and bagging of discharges are allowed to occur in the large cavity which will be present in the stump, unless this is obliterated by pressure, or sufficient drainage employed.

4. Entrance of air into veins.—This very nearly proved fatal in a case in which Mr. Jessop, some years ago, removed the scapula, outer half of the clavicle, and the upper extremity (*Brit. Med. Journ.*, vol. i. 1874, p. 12).

In this case the scapula seems to have been removed owing "to considerable deficiency of cover" after removal of an upper limb much damaged by a machinery accident. "Whilst cutting through the last attachments of the scapula, two distinct loud whiffs were heard, caused by the rush of air into the subclavian vein." The operation was completed while artificial respiration was being performed, and the lad recovered.

5. Recurrence.—While the results of this severe operation are, as far as immediate recovery goes, good, recurrence, in the case of periosteal sarcomata, takes place, as a rule, within six or twelve months. Thus out of forty-three cases in which the operation was performed for the removal of new growths, thirty-four recovered: of these the result is uncertain in ten; in fourteen recurrence took place, and in eleven of these within the year. Occasionally, in the case of the firmer and slower growths especially, viz., enchondromata, osteo-chondromata, it may be advisable to attack the recurrence.

In a case of Mr. Heath's (*loc. supra cit.*), recurrence took place seven months after extirpation of arm and scapula in a lad aged 16, with two years' history of the growth, an "osteo-sarcoma." The recurrent growth was removed, but two years and a half after the original operation there was a further recurrence, which was dealt with about five months later. A rapid recovery ensued, and at the time of this, the latest operation, no signs of extension to the internal organs could be detected, and the patient was in robust health.

6. If the patient survive, an artificial limb should be fitted at an early date. It may not admit of active usefulness, but it will be of service in preventing the feeling of most irksome lop-sidedness which in the convalescence and early getting about causes these patients so much difficulty in balancing themselves.

With regard to the *mortality*, Mr. Barling, in bringing two cases before the Clinical Society (*Brit. Med. Journ.*, vol. i. 1898, p. 883), stated that a collection of nineteen cases recorded since 1890 showed that all these recovered, indicating that the mortality of the operation, previously estimated at 21 per cent., was too high. He added that this operation had been performed eight times during the last ten years at the Birmingham hospitals, and that all the patients had recovered from the operation. Mr. Barling's first case was that of a man, æt. 53, whose history showed that the tumour commenced three and a half years previously, at which time there was a spontaneous fracture of the humerus. When the patient presented himself for treatment, the upper two-thirds of the right arm were occupied by a growth which overlapped the shoulder-joint, the outer end of the clavicle, and the spine of the scapula, filled the axilla, and stretched under the pectoral muscles. The growth was diagnosed as a myeloid sarcoma. The patient made a good recovery, but six months afterwards was the subject of many secondary growths. In the second patient, whose disease was of about seven months' duration, periosteal sarcoma was diagnosed. Here there was no recurrence fifteen months after the operation.

CHAPTER IX.

OPERATIONS ON THE CLAVICLE.

REMOVAL OF THE CLAVICLE.

REMOVAL may be occasionally required for new growths or necrosis. In either case it is but rarely called for. That for necrosis differs in no way, save for the importance of surrounding parts, from the same operation elsewhere.

Removal of the Entire Clavicle for New Growths.—The following are the chief points to bear in mind, viz., that—(1) The degree of malignancy of sarcomata of bone varies here, as elsewhere, within very wide limits. (2) That slowness of growth, a well-defined outline, regularity of expansion (p. 71), together with absence of swelling of the hand, will be favourable evidence. (3) A free incision is needed along the curves of the bone, with any additional one that is required. (4) Plenty of Spencer Wells's forceps must be at hand. (5) The acromial end should be set free first, either by opening the joint or by sawing the bone, if healthy. (6) The freeing of the coraco- and costo-clavicular ligaments is often a matter of much difficulty owing to their depth and the way in which the bone may be tied down by the growth. (7) With periosteal sarcomata of any duration, outlying processes may be present. (8) If this be the case towards the inner end of the growth, it will require the greatest caution to avoid opening up connective tissue which is continuous with that of the mediastina. (9) Division of the clavicle—a step sometimes taken to facilitate its removal—should be avoided, if possible, as the wound may thus become infected with growth. (10) As in all removal of bones infected with growth, the clavicle may fracture during operation; the outer end should then be seized with lion-forceps and dissected out so as to give more room for dealing with the sternal extremity. The account which follows, by Mr. Bowreman Jessett (*Lancet*, vol. i. 1889, p. 1077), of a case in which he removed the entire clavicle for a large subperiosteal sarcoma, shows well the sort of operation required, and the difficulties likely to be encountered:

The patient was a girl, aged 16; the growth was of more than a year's duration, and extended over the inner two-thirds of the clavicle. The following were the most important points which led the surgeon to recommend operation: The age of the patient. The fact that the growth (as shown in an illustration which accompanies the paper) extended much farther on to the chest wall than it did into the neck. It had originated on the front of the clavicle, and had only quite lately caused any pressure on the vessels. The skin was not implicated; while complete removal was doubtful and attended with much risk, if left the growth must inevitably have been fatal and, from pressure on the large nerves, attended with great pain.

A ⊣-shaped incision was made, the long limb along the clavicle and the shorter one over the sterno-clavicular joint and growth. Flaps being reflected, the muscles were detached from the bone as far as possible, and the outer fibres of the sterno-mastoid divided on a director. A metal spatula was next passed behind the bone at the junction of the outer and middle thirds, and the bone divided here with a narrow saw, the section being completed with bone-forceps. The inner fragment was then pulled forwards with lion-forceps, while the subclavius was carefully detached with scissors curved on the flat. Some difficulty was met with in opening the sterno-clavicular joint, as this was overlapped by the growth.* A further extension of this over the top of the first rib made it difficult to divide the costo-clavicular ligament, which was effected with scissors after suitable dragging up and rotation of the fragment and growth. Care was taken to leave untouched the sternal head of the sterno-mastoid. The anterior and external jugular veins were divided between double ligatures. The outer part of the clavicle was then seized with lion-forceps, and removed (a small portion of the periosteum at the extreme end being left) after division of the muscular and ligamentous attachments. There was very little loss of blood. The patient made a good recovery, and three months later "the movements were equally good with those of the opposite side." In 1893, speaking at a meeting of the Medical Society, Mr. Jessett said that several small recurrent growths had been removed.

In Prof. Mott's case (*Amer. Journ. Med. Sci.*, O.S., vol. iii. p. 100) the subclavius could not be seen, being incorporated with the diseased mass. This greatly increased the difficulty of keeping above the subclavian vein. This vein was firmly adherent to the growth, but was finally detached by the most cautious use of the handle and blade of the knife alternately. The patient lost from 16 to 20 ozs. of blood, but made a good recovery. The growth was an osteo-sarcoma, the size of two adult fists. The necropsy, fifty-four years later (the patient's death not being connected with the growth), showed that ⅜ inch of the acromial end had been left, the rest of the site of the bone being occupied by a ligamentous band. And the latter, no doubt, is the condition present in the other cases where the after use of the limb has been so good. The use of the arm is said to have been complete. In Mr. Travers's case, where three-fourths of the clavicle were removed, there was scarcely any restriction of the movements of the arm, one of the boy's amusements having been rowing on the Thames. Again, in a case in which the whole clavicle, save a small portion of the acromial end, was removed for a malignant growth, the man afterwards found no hindrance from the loss, being able to act as a bricklayer's labourer and miner.

Mr. Haslam brought a case before the Medical Society (*Lancet*, vol. i. 1893, p. 930) in which he had completely removed the clavicle five months before. The growth was a periosteal sarcoma, and examination showed that its amount was small in proportion to the new bone-formation. Some cartilage was also present.

Dr. Vaughan (*Med. News*, Jan. 8, 1898) performed complete excision for a mixed-cell sarcoma. Twelve months later the man was in good health, and had been carrying on his work as fireman on a steamboat. Here it was thought that suture of the detached sterno-mastoid and trapezius to corresponding points in the pectoralis and deltoid had contributed to the excellent functional result.

In February 1899, I saw my colleague, Mr. Symonds, remove the clavicle for a mixed-cell sarcoma. The outline of the bone was here masked by the growth, and the boundaries of the latter not well defined. The operation was rendered difficult throughout by the very free bleeding at all points, the extent to which the bone was tied down, and the consequent difficulty of getting at the coraco-clavicular and costo-clavicular ligaments. The patient made a rapid recovery, and remained well a year later.

A good instance of *partial* removal of the clavicle is recorded by Mr. Bland Sutton (*Clin. Soc. Trans.*, vol. xxiv. p. 12):

Here the acromial half was removed for a myeloid growth in a woman, aged 26. The chief difficulties met with were, first, the tightness with which the bony capsule was tied down over the coracoid process by the coraco-clavicular ligaments, these structures requiring careful division with scissors. Secondly, the supra-scapular nerve ran in a shallow groove in the capsule of the tumour, and was reflected without injury. Nearly four years later there was no evidence of recurrence. A fibrous band united the remains of the clavicle and the acromion, and the patient could perform all movements of the extremity perfectly.

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* In a case of Mr. Caddy's, of Calcutta (*Med. Rec.*, Nov. 19, 1892), in which the inner two-thirds of the right clavicle were removed for a periosteal sarcoma, the pleura and innominate vessels were exposed in dissecting away a tongue of growth which passed down behind the manubrium. The patient recovered with perfect movement of the arm.

OCCASIONAL CONDITIONS OF THE CLAVICLE OR ITS JOINTS WHICH MAY CALL FOR OPERATION.

A. **Fractures of the Clavicle.**—Operative interference may, very rarely, be called for in some of the following cases: (1) In recent cases with very marked displacement difficult to reduce or keep in position, as in fracture of the acromial end, outside the coraco-clavicular ligaments. (2) In compound and comminuted cases, after the wound has been enlarged so as to promote asepsis, wiring of the fragments will be quite justifiable, especially if they are comminuted. (3) In cases where, owing to excessive callus or pseudarthrosis, there is pressure on the nerves or vessels. (4) Where an ugly union or pointed process of bone presses on the skin or causes disfigurement.

An excellent instance of pseudarthrosis* in which pressure on the nerves supervened later, most successfully treated, has been recorded by Mr. Barker (*Clin. Soc. Trans.*, vol. xix. p. 104):

A boy, aged 12, was noticed soon after birth to have a fracture of the right clavicle, the cause of this being uncertain. Up to nine years of age the child had no inconvenience. He was then gradually more and more troubled with pressure on the brachial plexus, pain down the arm, and a tendency of the fingers to become stiff and fixed in a flexed position in writing, this condition soon amounting to one of painful spasm, rendering the writing quite illegible.

With a view of resecting the false joint, lifting the inner end of the outer fragment off the brachial plexus, and wiring it to the inner fragment, Mr. Barker operated as follows:

"Observing all the details of the Listerian method of antisepsis, I made a semilunar incision, about 3 inches long, with its two ends on the clavicle, and its convexity downwards. This corresponded to the middle of the bone, having the false joint above its centre. The flap of skin so formed was turned upwards off the bone, and with it I dissected up some fibres of the pectoralis with the object of securing that the nutrition of the skin should not be disturbed by dividing its deeper vessels. The bone being thus exposed, a false joint was found between the broken ends, which were united by fibrous tissue. I now divided the outer end of the inner fragment obliquely in a plane running from within outwards, and from before backwards. The section was made with Gowan's osteotome, and was done very cautiously, so as to disturb the periosteum and soft parts as little as possible, and obviate all risks to the vessels running beneath the clavicle. I then placed the osteotome on the inner end of the outer fragment, and divided it in a plane corresponding to that of the section of the inner fragment. Here my first cut was too oblique, and I withdrew the blade of the saw; but the second was accurately placed and sacrificed less bone. I now lifted the inner end of the outer fragment off the brachial plexus, and placed its cut surface resting upon that of the inner portion of the bone. A silver wire was then passed through both ends from before backwards, and twisted firmly. This seemed to secure sufficient fixation of the two portions, and the ends of the wire were cut, and the twisted portion bent level with the bone. The skin was then united with ordinary carbolised catgut, the edges of the pectoral muscle having been first brought together with stitches of the same. A strand of catgut was also inserted between the lips of the wound for drainage. No blood to any amount was lost, and the wound was a dry one; I therefore dressed it with powdered iodoform and salicylic wool, considering the latter more elastic than gauze. Plenty of ordinary wool was added for padding, and over all a plaster-of-Paris bandage was laid on. This was applied over a webbed vest precisely as for spinal caries, and completely immobilised the arm and shoulder for the month during which it was worn. To this perfect fixation of the parts concerned, quite as much as to the accurate apposition of the cut surfaces of the bone, the good result of the operation is, in my opinion, to be ascribed."

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* As a rule, non-union or pseudarthrosis of the clavicle does not cause the patient much trouble, if it has occurred in early life. Though the ends of the bone may be atrophied, the muscles will be found hypertrophied.

The dressings were not disturbed for fourteen days, when the wound was found united by first intention, except at one point where the catgut drain was still unabsorbed. There was not a drop of pus anywhere. A similar dressing was applied, and not removed for fourteen days, when all healing was complete. The plaster corset was then removed, and a mass of callus could be felt at the seat of operation. A week later the power of writing was found to be much improved, and the arm became perfect in all its functions.

Mr. Pollard (*Brit. Med. Journ.*, vol. i. 1887, p. 676) records a case of ununited fracture of about four months' duration, in an infant aged eighteen months, in which he resected and wired the fragments with an excellent result. Sound union followed, and the arm, previously hardly used at all, was moved as well as the other.

In those cases where much deformity has followed union of a fractured clavicle, it will be quite justifiable, with strict antiseptic precautions, to explore and remove the projecting bone with an osteotome or saw.

I have done this in a young woman in whom a very ugly projection remained after the union of a fracture some years before. The wound healed in eight days, and not only was the deformity removed, but the pain in the hand and weakness of the limb (no doubt very largely neurotic) disappeared entirely after this operation, which was performed at the patient's urgent request.

I think such steps may well be taken more frequently. The subclavius renders the important parts below the clavicle quite safe.

B. **Dislocations.**—It is well known that occasionally dislocations of the clavicle, especially those of the sternal end, are most difficult to maintain in place after reduction. Modern surgery will render wiring of the bone-ends after they have been curetted or resected, according to the damage done, safe and effectual.

In August 1899, I removed the sternal end of the clavicle for an old dislocation upwards and backwards in a patient at Guy's Hospital. Only the cartilage was shaved off on the sternal facet. The wire employed was removed in three weeks. When the patient left the hospital, five weeks after the operation, the deformity was entirely removed and the parts were soundly consolidated. Four weeks later he had resumed his work. He could raise his arm to a right angle, and the movements were increasing. It is fair to add that resection was performed by an American surgeon, Cooper, of San Francisco, as long ago as 1861 (*Amer. Journ. Med. Sci.*, April 1861), in three cases of acromio-clavicular dislocation. In each case the lesion was of several years' standing, and the usefulness of the limb much impaired. In all three the result was excellent.

C. **Disease of the Joints.**—It is well known how obstinately tubercular disease sometimes settles on the sterno-clavicular joint. The simplicity and the superficial position of this joint render erasion, followed, if need be, by removal with a chisel or osteotome of one or both bone-ends, a most successful operation, as I have found in two cases.

CHAPTER X.

SKIN-GRAFTING BY THIERSCH'S METHOD.*

THIS method, promoting as it does rapid and sound healing, and minimum of contraction, is often called for where large open surfaces are left to heal—*e.g.*, after burns, removal of a cancerous bosom on wide lines, ulcers of the leg, extensive lupus, and the like. The following steps must be carefully considered:

i. **Preparation of the patient and surface to be grafted.** The patient must be in satisfactory condition, and one who can be relied upon to keep absolutely still. The surface must be either a recently-made wound, or, if an ulcer of any kind, one in which healing has begun. But, above all, it must be aseptic. If the surface be foul, there is nothing better than the application of pure carbolic acid† to the ulcer itself, followed by creolin fomentations. The adjacent skin must be shaved over a sufficient area after thorough soaping, then cleansed with turpentine, and again carefully purified with soap and a nail-brush. In two or three days' time one of the usual aseptic dressings is applied, viz., iodoform gauze wrung out of carbolic acid lotion (1 in 30), and green protective, or cyanide gauze out of a sublimate solution (1 in 4000). Either gauze is bandaged on with salicylic wool. The shaving should be repeated every four days.

ii. **Preparation of the area from which the grafts are to be taken.** Thirty-six hours before the operation the skin of this area is to be carefully disinfected in a manner similar to that already detailed, especial care being given to such regions as the axilla, and an aseptic dressing must be worn up to the time of the operation.

iii. **The actual grafting.** The anæsthetic having been given, and the surface to be grafted exposed, the superficial layer of granulation tissue is to be removed together with the edge of the ulcer, whether healing or no. Every atom of the watery layer of granulations should be removed with a sharp spoon. The next step is to arrest the free oozing which follows. This is effected by firm pressure, applied by means of green protective[*] and salicylic wool firmly bandaged on. The surface from which the grafts are to be taken is now exposed and again cleansed. The operator, with his hand placed under the limb, stretches the skin from side to side, while assistants keep it on the stretch above and below. With a broad and heavy razor (carefully sterilised) the grafts are now taken. The blade is placed at such an angle to the skin, that when it is entered and carried along it will remove a thin shaving of the epidermis, filmy and greyish-white, falling at once into delicate folds as it is cut, and exposing, and only just exposing, the tops of the papillæ. It is then carried on with a lateral sawing movement. The skin must be kept carefully on the stretch all the time, and the razor must be wetted from time to time with a few drops of sterilised salt solution or boracic acid.[†] The grafts should be about two inches wide, and four or five inches long, and should consist only of the horny and the superficial part of the Malpighian layer, the tops of the papillæ being only just touched upon.[‡] Any tendency they may show to curl up in front of the razor should be checked by an assistant carefully keeping the part cut on to the razor. When the cutting of each graft is finished, an assistant should set it free by one stroke of a pair of sharp scissors. If the bleeding on the area to be grafted has ceased, the grafts should be transferred directly on the razor or a microscopical section-shifter (Ballance), laid down each on their cut surface, and then gently and evenly flattened out with a needle. If the bleeding has not ceased it will be preferable to follow the advice of Watson Cheyne and Burghardt (*vide supra*), and to leave the grafts lying on the bleeding surface, this plan being more likely to retain the vitality of the grafts than that of putting them into a warm saturated solution of boracic acid. All layers of clot, oozing or other liquid, must be carefully removed from the surface to be grafted, with dossils of gauze. The writers just mentioned give the two following useful hints: "The grafts should overlap the edges of the skin, and also each other, so that no part of the raw surface is left exposed, for granulations always spring up on the uncovered parts; furthermore, a thin scar, which may subsequently break down, is left at these points. In spreading out the graft it will be found that air-bubbles collect beneath it, and also that some amount of oozing goes on, and the bubbles and clot may prevent complete adhesion of the graft. Hence, the next procedure is to get rid of them by pressure. If that be attempted by means of sponges in the hands, the graft is apt to be displaced. The following is the best plan: Strips of protective about an inch in breadth, and long enough to overlap the edges of the wound, purified in 1—20 carbolic lotion, and subsequently rinsed in boracic lotion, are applied firmly over the grafted surface, beginning at the lower part. Each strip should overlap the one below, just as in the case of strapping, and they should extend well on to the skin at each end. If each strip as it is put on be grasped by the two ends and firmly pressed down, the pressure thus applied suffices both to expel the air-bubbles and blood, and also to arrest further capillary oozing." When the surface to be grafted is completely covered with grafts and strips of green protective, a dressing of iodoform or cyanide gauze and salicylic wool is applied, with firm, even pressure. If the surface be on a limb, this must be kept at rest on a splint. The surface from which the grafts were taken is next dressed in the same way as the ulcer, this dressing being left on for a week or ten days. The dressing on the grafted surface should be left undisturbed for five or more days, if possible. Its removal must be effected with much carefulness; gentle washing with dilute carbolic acid, sublimate, or lysol lotions, or careful syringing should be employed lest any of the grafts be peeled off with the protective. All is doing well if the grafts have a pink colour and are adherent. If white or greyish in tint they are no longer alive.

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* I have inserted this here, as I prefer to take the grafts from the skin of the shoulder, arm, and forearm. Others—viz., Watson Cheyne and Burghardt (*Surg. Treat.*, pt. i. p. 50) [the account given by these writers is most practical and helpful; I have taken many hints from it], and Duplay and Reclus (*Traité de Chir.*, t. i. p. 278) —recommend the front of the thigh. I prefer the first region, as possessing more vascular and more easily sterilised (because less hairy) skin. It further presents obvious advantages in women.

† If for any reason the use of carbolic acid is contraindicated, and other aseptic solutions cause irritation, a saturated solution of boracic acid should be used. This will need attention as to its renewal.

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[*] This must be used now: otherwise, gauze or sponges, when removed, would cling to the surface and start fresh bleeding.

[†] The usual powerful aseptic lotions may injure the vitality of the grafts, and, if the surfaces have been rendered aseptic, such lotions will no longer be needed.

[‡] A test of the proper depth cut into by the razor is shown by the nature of the bleeding, and the rate at which this follows. It should be minutely punctiform, very slight, and slow in making its appearance.

The *technique* of grafting on a fresh wound is in all essential points similar to the above.

PART II.

THE HEAD AND NECK.

CHAPTER I.

OPERATIONS ON THE SCALP.

BUT few—viz., those for large fibro-cellular tumours, and the vascular tumours known as aneurysms by anastomosis, &c.—will require mention in a work like this.

FIBRO-CELLULAR TUMOURS, OR MOLLUSCUM FIBROSUM.

These rare growths occasionally require removal, on account of their hideous deformity.* The chief points of importance in such operations are—1. The hæmorrhage. This may be terrific,† copious, and weeping from every part, owing to the huge size of the growth and the vascularity of the parts. It is best met by an ingenious precaution of Mr. Hutchinson's,‡ who prevented all arterial hæmorrhage during an extensive operation of this kind by applying round the head, just above the ears, a Petit's tourniquet with a narrow strap, cotton-wool being placed over the eyes. In a smaller case, strong india-rubber bands, with pads over the chief arteries, may perhaps be useful. (2) The need of maintaining strict asepsis. As nearly the whole thickness of the scalp affected must usually be sacrificed, the pericranium may be damaged and the bone necessarily exposed. The risk of septic osteitis and then phlebitis of the veins of the diploë is well known, with the inevitable result of pyæmia. Thiersch's method of grafting (p. 188) will be very useful, either at the close of the operation or later on.

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* A good illustration of these growths is given by Mr. Hutchinson (*Lond. Hosp. Rep.*, vol. ii. frontispiece), and another by Sir J. E. Erichsen (*Surg.*, vol. ii. p. 533). The drawing in this case is said to be taken from a patient of Sir W. Stokes'. This surgeon figures an excellent one (*Dub. Journ. Med. Sci.*, vol. lxi. N.S., frontispiece).

† It is so described by Sir W. Stokes (*loc. supra cit.*). The patient, a man aged 33, in good condition, almost died on the table. Nélaton's method of inverting the head was made use of, with excellent results.

‡ *Loc. supra cit.*, p. 118. The piece of scalp removed here was twice as large as the palm of the hand. Owing to the precautions taken, there was no arterial hæmorrhage. In Sir W. Stokes' case the base of the growth was very wide, reaching from above and in front of the right ear to the left of the occipital protuberance, upwards as high as the vertex, and hanging down as low as the shoulder. In such a case, Mr. Hutchinson's plan might be made use of by applying the tourniquet carefully round the lower jaw and nape of the neck if it could not be applied from the latter point obliquely upwards on to the forehead, the strap being kept low in position, if needful, by loops of bandage passed under it on either side, and drawn downwards by assistants.

ANEURYSM BY ANASTOMOSIS.

The treatment of these sometimes most difficult cases is given under the head of "Ligature of the External Carotid."

QUESTION OF OPERATIVE INTERFERENCE IN GROWTHS OF THE CRANIAL BONES AND DURA MATER.

Under this heading are included all these malignant growths, usually sarcomatous, which, springing from the scalp* (often the pericranium), the diploë,† the meninges, and, more rarely, the brain, are capable of perforating the skull from within outwards, or in the reverse direction. The parietal bone is a favourite site, and childhood or young adult life is the ordinary period for their appearance; and, at the earlier of these periods especially, operation is most unfavourable. It remains to be seen what operative attacks, aided by antiseptic surgery, may avail in these cases, but for the present, unless an opportunity arise for attacking such growths quite early—*e.g.*, while they are only of small size—it will be wiser not to interfere.‡ And this warning is especially true of those cases in which sarcomata of a specially malignant kind appear, often after an injury, on the crania of children,§

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* M. Terrier (*Bull. de l'Acad. de Méd.*, 1891, p. 184) records a case in which an epithelioma, starting in a scar, involved the dura mater over the frontal region. It was removed successfully, but the history is only carried up to two months after the operation.

† While the vault is affected more often than the base, sarcomata of the skull may be present in both situations simultaneously.

‡ Further carefully recorded cases, with post-mortem records, paying especial attention to the possibility of removal, are much needed here. An interesting case is published by Mr. Morris (*Path. Soc. Trans.*, vol. xxxi. p. 259). The disease here certainly took six years in running its course; other deposits were present. The patient died away from London. The growth is stated to have begun in the diploe, and to have compressed, not involved, the brain. Dr. Drummond, of Newcastle, published three interesting cases (*Brit. Med. Journ.*, vol. ii. 1883, p. 762). In none of them was any operation possible. Other instances of sarcomata of the cranial bones or the dura mater are figured by Tillmanns (*Textbook of Surgery*, vol. ii.).

§ A good instance of such traumatic sarcomata is recorded, with illustrations, by Mr. Hewetson, of York (*Lancet*, vol. i. 1893, p. 1441).

where the swellings of the scalp are multiple, or where they are travelling out of the skull by any of the apertures, *e.g.*, the orbit.

The following case is a good instance of these growths, though there was much uncertainty as to its exact origin. The question of operation, as mentioned below, was repeatedly discussed here.

D. E., aged 28, a Welsh miner, was sent to me, in 1885,* by Dr. Evans, of the Rhondda Valley. Three years previously he had noticed a swelling, the size of a pigeon's egg, in the centre of the right parietal bone; for a year previous to this he had pains in the head. During his work in the mine, his head had received repeated blows, many bluish characteristic scars being present. A month after the swelling appeared, fits began to occur nightly, and lasted thus for three months; then they gradually became fewer, and for the last year there had been none at all.

At a spot 2 inches above the left ear was a large elevation of the scalp, measuring nearly 5½ inches in one diameter, and about 4¾ in the other. There was no ulceration of the scalp tissues here, but unusually large vessels were to be felt over the area thus prominent. In the centre the bones of the skull appeared to be deficient over a circular spot the size of a shilling, as here the scalp could be deeply dimpled by finger pressure as if through a ring of penetrated cranial bone. Over this central gap, pulsation was strongly marked and rather heaving; it was also present, to a less degree, over the rest of the swelling.

At other parts of the area of the growth, especially at several spots in the periphery, was a remarkable feeling as if of bony, trabecular structure. It was doubtful whether this was brought about by growth invading a flat cranial bone, or to calcification taking place in the periphery of a sarcomatous growth. On a level with the left ear was an enlarged gland.

Dr. Targett, then Surgical Registrar, reported that double optic neuritis was present, but no oculo-motor paralysis. The reflexes were normal, and there was no loss of sensation or motion.

There were no urgent symptoms: the patient had occasional throbbing and pain in the swelling, but no obstinate headache and vomiting; he was able, as yet, to work, and stipulated that no operation involving risk to life should be performed.

For these reasons, and because, owing to the size, duration, and characters of the growth, the risk of attacking it was undoubtedly great, the patient left the hospital without anything being done.

Unless such a case can be seen very early (and this is just the stage which does not come under the notice of the surgeon), the following would appear to be amongst the difficulties and risks of an operation in these cases:

The necessary difficulty and tediousness in isolating the affected bone, if of any size, by sufficient trephine crowns, and joining these with a Gigli's saw (p. 306), or the forceps of De Vilbiss (p. 308), or a chisel.† It must be remembered that the overlying soft parts were extremely vascular and perhaps (from the enlarged gland) already involved in the growth. In isolating and going wide of the affected bone, it was uncertain whether one or more sutures would not have to be crossed, and sinuses, such as the superior longitudinal, met with and need securing (this, whether by underrunning or otherwise, not being always an easy matter), thus leading to profuse hæmorrhage. In addition to this source of hæmorrhage there is that certain to be met with in dealing with the soft parts and with the diploë around the affected bone.*

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* He was still alive in 1890.

† The best means of removing bone from the skull on a large scale are given at p. 305. I would also refer my readers to Mr. Battle's instructive case (p. 195), and *Clin. Soc. Trans.* vol. xxxii. p. 132.

Then, supposing the bone sufficiently removed, wide of the growth, in one or more pieces, if the growth were from the dura mater, this membrane must certainly be dealt with, and the same would very likely be the case if, originating in the diploë. the growth had crept inwards. In further isolating the disease, if it had merely pressed upon the brain and not involved it, most delicate work would be required: enlarged branches of the middle meningeal and, very likely, dilated sinuses would require dealing with. If the disease had involved, instead of merely displacing, the brain, new and special risks would have to be encountered just when the patient's condition, after an already prolonged operation, was least fitted to bear them.

Such are amongst the chief difficulties and dangers which appeared to me very likely, if not certain, to be met with. They do not seem to me to be exaggerated.

Moreover, in these and in any other prolonged operations which deal with the brain and its membranes, the fact must never be lost sight of that, what with the necessary interference with very vital organs, and what with the anæsthetic, the margin left to the patient between life and death may be a very narrow one.†

Even if the growth is small and circumscribed, and there is good reason to believe that it is single, it will probably be wiser to divide the operation into two stages, as in Mr. Battle's case given below, if the dura mater be involved.

Another similar but distinct class of these growths is formed by those epitheliomata of the scalp which have extended through the cranium to the dura mater or even the brain. Tillmanns (*Surgery*, vol. ii.) gives good illustrations of two such epitheliomata involving the frontal region: one, in a girl of 14, which perforated the skull, was successfully removed by Braun; the other, in a man of 56, was operated on by Tillmanns.

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* An attempted removal of a growth, afterwards proved to spring from the dura mater, is recorded by Sir W. Lawrence (*Med. Times and Gaz.*, 1853, vol. ii. p. 129). The operation was abandoned owing to the hæmorrhage. The patient died about two months later. Volkmann lost a patient with sarcoma of the dura, from the entrance of air into the superior longitudinal sinus.

† About eleven years ago I had occasion to explore and attempt the removal of a glioma, proved later to occupy almost the entire right frontal lobe of a patient at Guy's Hospital. The pulse failed so ominously with chloroform that, after removing one crown, ether was given while the trephine was applied again, and the two openings thrown into one. The substitution of this anæsthetic was followed by so much cyanosis and jerky, gasping, irregular breathing, with a fixed chest (the patient was a young man, much emaciated by vomiting and headache, but free from any lung trouble), that it was decided to do no more that day. The patient never "came to," and died comatose a few hours later. In this case there had not been time to interfere with the brain and its membranes. Another patient of mine, admitted for epileptic seizures connected with a huge cancellous exostosis of the frontal bone, which, as it proved, was pressing inwards upon the brain and membranes, had been under observation for a fortnight, his diet being strictly regulated. On the evening of Christmas Day, his diet having been not unnaturally, but too suddenly, altered, a severe epileptic seizure came on; this was followed by coma, rapidly deepening into death. I have elsewhere (p. 213) alluded to the suddenness with which respiration may fail in patients the subjects of middle meningeal hæmorrhage.

Here recurrence rapidly took place. A very instructive case of carcinoma[*] of the frontal region, involving the skull, was successfully operated on by Mr. Battle (*Clin. Soc. Trans.*, 1899, vol. xxxii. p. 127):—

The patient was 35, and during the previous eight years several operations had been performed. The growth measured 3 inches by 4½, bled freely, and could not be moved over the subjacent bone. There was no pulsation in it, and the glands appeared to be normal. Removal was effected by operation in two stages: "Cotton-wool having been placed over the eyes, a Martin's bandage was passed round the head below the occipital protuberance and over the root of the nose; an incision was then made to the bone about ½ inch from the edge so as to completely encircle the growth. The mass was then rapidly separated from the bone with the handle of the scalpel and a periosteal elevator. The only hæmorrhage came from places in the bone which had been invaded by the growth, and firm pressure with a sponge readily controlled it. Several vessels were then secured, but after the removal of the Martin's bandage there was pretty free bleeding. Pressure arrested this until vessels could be caught. Several arteries required ligature, and one or two a ligature passed round them by means of a curved needle. On the whole, there was no great loss of blood. The sponge placed over the growth where it passed into the bone was left in position, and the dressings were applied firmly over this. Next day the dressings and the sponge were removed, and extra pressure was no longer applied. It was evident that the bone was affected to a considerable extent, although it was not certain that the growth had passed completely through in more than one place."

On a later occasion—the exact date is not given—the bone was removed partly by a hand-motor working a trephine and circular saw fitted with a special guard,[†] and partly by a chisel and Hoffmann's forceps. "The amount which required removal was placed about the centre of the frontal bone, and was about 2½ inches in width. A trephine-crown was removed to the right of the area marked out; there was a good deal of difficulty in doing this, as the bone was very hard and thickened. A raspatory was then passed under the bone to determine whether the growth implicated the dura mater; this could not be made out with certainty. There was some difficulty in starting the saw owing to the great thickness of the bone. A chisel and Hoffmann's forceps were accordingly used to make a beginning, and the saw applied afterwards. By the alternate use of these instruments about a third of the circumference was divided. The saw was then started in the other direction from the trephine-hole, and worked much more quickly, till there was only about an inch left uncut. Up to this time there had been very little bleeding, but now bleeding was free. A chisel was used to cut through part of the remaining bone, and then the circle of bone was raised from the other side, and the last piece gave way. The bleeding was seen to come chiefly from a point in front in the middle line in the dura mater, just under the edge of the bone. Bleeding from this point was temporarily arrested by finger pressure. The under surface of the bone presented in one part an area of softened tissue about the size of a raisin. The appearance of this was very like that of the flattened papillomata sometimes seen on the palate; this growth did not in any way involve the dura mater—in fact the dura mater was quite healthy." The bleeding point in the dura mater was arrested by pressure with gauze packing. At a later period the granulating surface was grafted.

Mr. Battle's remarks on the mode chosen for removal of the cranial bone are very noteworthy: "Of the principal methods of removing large portions of the skull, the one which was brought to my notice by Messrs. Down—that of a circular saw worked by a motor—appeared the most likely to fulfil the object in a satisfactory manner. There was, however, much difficulty in guiding the saw along the line which I had selected, and it travelled slowly through the dense bone, whilst the cable attached to it was cumbrous and difficult to hold. Were I again called upon to perform a similar operation, or one requiring the excision of much bone, I should use the method, since suggested, of the wire saw, worked across from one trephine opening to another, and applied from within outwards."

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[*] Mr. Shattock pronounced the growth to be a spheroidal-celled carcinoma, probably originating in the glandular structures of the skin.

[†] Supplied by Messrs. Down. The use of electro-motor trephines is referred to on p. 305.

CHAPTER II.

TREPHINING.

OPERATIVE INTERFERENCE* IN IMMEDIATE OR RECENT† FRACTURES OF THE SKULL.

Indications.—The chief of these are:

i. COMPOUND DEPRESSED FRACTURES.—Whether symptoms of compression are present or no, these fractures should, as a rule, be explored by reflecting adequate flaps, then elevating any depressed fragments, and removing any which are quite loose. At the same time the surface of the dura mater, where exposed, should be carefully scrutinised, and, together with the rest of the wound, thoroughly cleansed.

With regard to "thorough cleansing," I may draw the attention of my younger readers to the following forcible remarks of Prof. Nancrede (*loc. supra cit.*): "Suppose a recent head-injury just brought into the hospital, how should we proceed? Do not carelessly pass the forefinger through the filthy, blood-matted hair and explore at once the depths of the wound to ascertain its nature, as is too commonly the rule, but carefully shave the scalp, scrub it with a nail-brush, soap and water, remove all fatty matter with ether or turpentine and alcohol, completing the disinfection by a thorough irrigation with mercuric bichloride solution."

Operative interference is indicated in these cases for two reasons: (*a*) Even if no symptoms of compression are present at first, secondary inflammation is very likely to follow in a few days, it not having been possible by expectant treatment to completely cleanse the wound. If, now, some minute fragment of the brittle inner table has pricked the dura mater, fatal septic meningitis is almost certain. Should, therefore, the surgeon, in these cases, wait for evidence of compression as a justification of operative interference, he will too often wait till it is too late. Evidence of the presence of dirt,‡ especially of dirt ground down to, or into, the bone, is a reason for exploring the wound, even if no symptoms of compression are present. (*b*) If the patient recover from the immediate effects of the fracture, injury to the inner table, insufficient to cause symptoms at the time, and not detectable save by an operation, may be present all the time and cause much future trouble. In the words of Prof. Nancrede (*Intern. Encycl. of Surgery*, vol. v. p. 24): "Undoubtedly, many patients recover in whom the bone is not elevated, but in too many epilepsy, insanity, chronic cerebral irritation, &c., render life a burden, and operations are then required, which often prove useless.* . . . . Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation driving the dura mater against the bony fragments, Nature throws out osteophytic growths, which eventually—perhaps after years—set up serious trouble." The surgical treatment of traumatic epilepsy is now, when a large number of cases operated upon have been honestly watched, found to be very disappointing (p. 222). It is by a more frequent immediate exploration of all doubtful injuries to the head that we may best hope to bring about a diminishing frequency of traumatic epilepsy. (*c*) Locality is, of itself, an indication for interference. Thus aphasia may follow on a fracture over the region of the anterior inferior angle of the left parietal, and paresis on one, apparently trivial, over the motor area. Moreover, it is injuries to the frontal and parietal regions which, if left unexplored or insufficiently treated, are so liable to be followed by epilepsy.

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* This term is used to include the use of the elevator and dressing-forceps as well as that of the trephine, a matter which is alluded to again below (footnote, p. 202).

† By these terms it is intended to make a distinction between those cases in which operative interference is made use of within a few days after a fracture, and those in which it is only had recourse to a long time after the injury (see p. 221, "Trephining for Traumatic Epilepsy").

‡ To prove that it is not only the risk of pressure on, or injury to, the brain, but also the entrance of septic matter, that indicates the use of the trephine, Wagner

ii. SIMPLE DEPRESSED FRACTURES.—Where symptoms of compression are present, operative interference is the only course open. But where no such symptoms are present, the expectant treatment is by most surgeons held to be sufficient. We may perhaps come best to a decision as to using operative interference in simple depressed fractures, without symptoms, by dividing them into the three following groups:—

1. Where the depression extends over a considerable area, where it is slight in degree (*e.g.*, not more than a sixth of an inch), especially if the patient be young and the bones yielding, expectant treatment is no doubt the best.

2. But, on the other hand, where the depression is limited and defined, where the depressed fragment not only affects a small area, but is turned down angularly or edgeways, operative interference should be resorted to at once, even though no symptoms are present.

(Volkmann's *Samml. klin. Vorträge*, pp. 271, 272)—I am indebted to Prof. Nancrede for this reference—points out that it has been shown in more than one instance that even a hair caught in a fissure will certainly produce infection if not promptly removed. The same writer puts the mortality of immediate trephining at only 1·23; that when twenty-four hours or more had elapsed, at 33·33 per cent.

* Dr. Gunn (*Trans. Amer. Surg. Assoc.*, vol. i. p. 89), speaking of later trephining for the relief of old depressed fractures, says: "Although results of these secondary operations do not show a flattering percentage of success, I think that the reason may be looked for in the late period at which the operation is performed. It is rare that the patient submits to the dreaded operation till years have been wasted in the vain endeavour to effect a cure by medication. In the meantime, the constant irritation has begotten a permanent impression upon the brain and nervous system, which remains after the offending point of irritation has been removed."

and whether there is a wound or no, to prevent the onset of dangers, immediate and remote, fully alluded to later on.

3. There is a large class of cases intermediate between the above, where the fracture is a simple one, where symptoms are absent, and where the depression is sufficient to cause anxiety, though not so sharply defined as to call imperatively for operation. Here, when in doubt as to the severity of the case, the surgeon, if able to rely on his operative skill and on the wound running an aseptic course, will do best to explore the fracture. This is especially the case in fractures of the frontal and parietal regions, owing to the frequency with which these are followed, at a later date, by epilepsy.

Finally, in any fracture in which the question of operative interference arises, the kind of violence must be remembered. Was this concentrated over a small area, and thus likely to bring about serious depression and comminution of the internal table, or was it indirect and diffuse, and thus likely to have produced a long fissure-fracture with little depression, but perhaps tearing open meningeal vessels or sinuses, opening up the middle ear, nose, or pharynx, and spreading far into the base?

Influence of Site.—It is often said that a depressed fracture, even if distinctly marked, over the frontal sinuses, does not require operative interference, and that any such steps should be avoided for fear of leaving a fistulous opening leading to passage of air and troublesome emphysema. But it must be remembered that these sinuses do not appear before the age of fifteen or sixteen, and that, even in adult skulls, the extent of their development is most uncertain, the sinuses being sometimes represented by a small unilateral cell instead of fair-sized bilateral cavities.* Other sites, which it is well to avoid in trephining, if possible, are the position of large sinuses,† that of the trunk and chief branches of the middle meningeal artery,* and also the lines of the sutures, apart from any subjacent sinuses, as here the dura mater is firmly attached, unless it chance to be loosened by a violent blow. *Age*, too, must have proper weight attached to it, it being well known that in the first few years of life a very considerable depression may take place after an injury, and yet be followed by absence of head symptoms and by spontaneous recovery.†

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* Hilton, *Guy's Hosp. Rep.*, second series, vol. viii. p. 362. *Notes on the Cranium*, p. 8 *et seq.* See p. 261, a case of fatal injury to this region.

† It is worth while to bear in mind that if a large venous sinus is opened into, the hæmorrhage is usually at once arrested by *very moderate pressure applied at the right spot.* The pressure should be made by a sterilised finger, and kept up if needful by a pledget of sterilised aseptic gauze, left *in situ* for two or three days if possible. Dr. Cameron (*Lancet*, 1884, vol. i. p. 931) was able to complete a trephining while very slight pressure with lint controlled the bleeding from a wound in the superior longitudinal sinus. He points out that the imaginary fear of fatal hæmorrhage from such a wound may at times deter from a necessary operation with the trephine, and it is well that it should be dissipated. Dr. Hopkins (*Ann. of Surg.*, vol. ii. No. 7, p. 67), in a case of extensive compound fracture of the skull, found that a small lint-compress, dusted with iodoform, lightly applied to a wound in the superior longitudinal sinus exposed by elevation of fragments, readily arrested the hæmorrhage, which persevering efforts with tenaculum-forceps had failed to check with a ligature. Dr. Parkes (*Ann. Anat. and Surg.*, vol. viii. p. 118), in treating a wound caused by a fracture of the skull, arrested the terrific hæmorrhage first by pressure, and then by introducing three fine catgut sutures. These entirely closed the rent and controlled all bleeding, and though the calibre of the sinus was reduced fully one-third, and the sinus bulged markedly at the anterior extremity of the sutured wound, showing interference with the backward blood-flow, there was no evidence of cerebral disturbance due to this interference with so large a column of blood, the wound healing well with antiseptic precautions. The strictest antiseptic methods should be employed in dealing with wounds of these sinuses owing to the great risk of septic phlebitis and pyæmia.

iii. PUNCTURED FRACTURES.—Here, however slight be the injury to the outer table, that inflicted upon the inner is certain to be much more serious. And the more the diploë is present, the more extensive will be the damage which its fragments, when driven down, will inflict upon the brittle inner table. It must be remembered that punctured fractures, with all their serious results, may be caused by blunt, though pointed, bodies as well as by sharp ones.‡ Instances of these are, blows with a pickaxe, fragments of brickbat, coal, stone, the trigger of a clubbed gun, or falls on a fender-ornament. Immediate operative interference—and here, owing to the limited injury to the outer table, the trephine will be called for—is imperatively demanded in all punctured fractures, however insignificant be the damage to the scalp and outer table.§

iv. IN SOME CASES OF FRACTURE ABOUT THE INNER ANGLE OF THE ORBIT.—A small trephine should always be used (together with a small gouge) in exploring those grave injuries which may be caused by direct violence from thrust-wounds at the inner angle of the orbit, or root of the nose—*e.g.*, with scissors, slate-pencils, ferrules of walking-sticks, &c.

The apparent slightness of these injuries, the trifling wound, the period of latency of symptoms, and the onset of fatal brain mischief—

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* The treatment of hæmorrhage from the middle meningeal artery is given at p. 215.

† Good instances of this are given by Mr. Le Gros Clark (*Diagnosis of Visceral Lesions*, p. 94), Mr. Bryant (*Surgery*, 2nd ed. vol. ii. p. 357), Prof. Nélaton (*Pathologie chirurgicale*, tome ii. p. 149). The last two are accompanied by illustrations. On the other hand, a case by Dr. Haynes, of Evesham (*Brit. Med. Journ.*, 1897, vol. i. p. 203), shows that urgent symptoms may arise very early in life. A child, aged two years and five months, after a slight fall was found to have a deep indentation on the upper part of the right side of the head, and convulsive twitchings of the left arm and leg. Dr. Haynes, on exploring the injury, found a fracture "with a good deal of depression." An uninterrupted recovery followed after trephining and elevation of the bone.

‡ Prof. Nancrede (*loc. supra cit.*, p. 18) points out that a punctured fracture caused by a sharp instrument may consist of merely a splitting off of a small scale of the inner table, but that a blunt-pointed body will comminute the inner table extensively by breaking up the diploë.

§ "Hence it follows that exploratory perforation of the cranium is justifiable in all cases where the nature of the impinging force or the appearance of the external table renders spiculation of the inner table probable; provided that less danger to life and health is inherent in perforation than in the probable spiculation. . . . . Whenever the fracture presents the possibility of the inner table being detached and splintered more extensively than the outer, I should be inclined to advise perforation. In other words, I would cut the scalp to see the condition of the outer table, and I would cut the bone to see the condition of the inner table, in every case where the risk of obscure knowledge is greater than the risk of divided scalp and perforated bone." —Dr. Roberts, *Ann. of Surg.*, vol. ii. No. 7, p. 14.

inevitable, though delayed, if let alone—are all well shown in the following case of Mr. Hulke's:*

A little girl, aged 6 years, falling with a piece of slate-pencil in her hand, it pierced her right eyebrow near its inner end, and broke short off. Admitted soon after into Middlesex Hospital, the house-surgeon took out of the wound several splinters composing, he thought, the whole piece, covered the wound with a pad of lint, and had the child placed in bed. Her general condition did not betray the serious nature of the injury. She slept quietly through the night, and next morning did not appear much worse for the accident. In the afternoon, when I then first saw the child, I detected with the probe another splinter of the pencil, and, enlarging the little puncture, exposed a piece of pencil tightly plugging a hole in the bone. Enough of this was cut away cautiously with a gouge to allow the pencil to be grasped with a forceps. It proved to be shattered, and splinters representing a cylinder three-quarters of an inch long were removed. Intracranial inflammation—indicated by convulsions, delirium, a high temperature (103°) and rapid pulse—supervened. On the ninth day after the injury the temperature fell to 97·5° (the child had passed a quiet night, and took her food better), and from this date it continued subnormal, or only slightly exceeded the normal average, until the sixteenth day, when it rose suddenly to 104°. With this elevation of temperature were associated restlessness, delirium, a flushed face, screaming, vomiting, convulsions, and coma. Death occurred about twenty-four hours later. At the necropsy, a large abscess was found in the frontal lobe of the right hemisphere. It enclosed a piece of pencil about an inch long, and it had evidently quite recently burst into the anterior horn of the lateral ventricle. It is a matter of regret that the trephine was not employed instead of cutting away the bone around the pencil, which had the effect of loosening the splinters, and contributed to the fatal mistake that the whole piece of pencil had been removed.

v. FOR THE REMOVAL OF FOREIGN BODIES FISSURING OR FRACTURING THE SKULL.—These are rare—*e.g.*, penknife-blades, pieces of stone, bullets, &c. To ensure certainty of complete removal the trephine will usually be required.

The following cases show how the gravest results may ultimately follow on the overlooking of a small piece of knife-blade. Both (the first case especially) are good instances of the long time which occasionally intervenes between the injury and the onset of urgent symptoms due to abscess.

The first case is given by M. Dupuytren:†

"Il y a huit ou dix ans, un jeune homme reçut dans une querelle un coup de couteau sur le sommet de la tête ; ce couteau se rompit dans la crâne, après l'avoir perforé. Le chirurgien qui pansa le malade n'examina point avec tout le soin désirable l'état de la plaie ; il en rapprocha les bords, et le malade guérit. Plusieurs années se passèrent sans accidents ; seulement, de temps en temps, la malade ressentait des douleurs dans sa cicatrice. Au bout de quelques années, sans cause connue, il lui suivait un assoupissement très-fort de la fièvre ; il vint à l'Hôtel-Dieu et y fut reçu. En examinant sa cicatrice, je sentis qu'elle était soulevée et dessous elle un corps étranger ; j'incisai et fis l'extraction d'une portion pointue de lance de couteau, à l'aide du trépan. Les accidents persistèrent, il s'y joignit la paralysie du côté du corps opposé à celui de la tête qui était blessée. J'incisai la dure mère, il ne sortit rien ; je plongeai un bistouri avec précautions dans le cerveau, et il jaillit de suite un flot de pus. Le soir même de cette opération, tous les accidents disparurent, la fièvre, la somnolence et la délire; et le malade guérit."

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* *Syst. of Surg.*, vol. i. p. 586. As here pointed out, the injury is especially likely to be overlooked if the instrument has slipped under the lid, and so reached the roof of the orbit and base of the skull, leaving, it may be, merely a patch of ecchymosis on the conjunctiva.

† *Leçons orales de Clin. Chirurg.*, second ed. vol. vi. p. 146.

In the following case of Prof. Nancrede's,* the apparent slightness of the injury, the long absence of symptoms, then their sudden onset, the difficulties met with during trephining, the results of promptly meeting them, and, finally, death due to a hernia cerebri, are all deserving of careful attention:

On March 6th, J. Y., aged 19, walked into the Episcopal Hospital, complaining of a sore on the top of his head, the result of a blow received two months previously. On examining the wound, in the centre of an ulcer, located about the position of the left middle parietal lobe, was found the broken edge of a knife-blade. On being told of this he seemed thoroughly surprised. But little could be made out as regards the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not, at that time or afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed, but in the afternoon of the same day he had slight pains in the head. March 7: He had slept well. No headache, temperature 100°. Slight retinal hyperæmia. March 8: Epileptiform seizures set in to-day, beginning with twitching of the right arm, but soon becoming general. Prof. Nancrede trephined over the seat of injury, the bone removed showing a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. During the next three weeks the fits apparently ceased, but symptoms indicating cerebral abscess—viz., temperature often low, 97½°–98°, slow pulse, marked mental dulness—set in. March 30th: Temperature 99°, pulse 70. The patient was unconscious, with right-sided hemiplegia, and rapidly sinking. Prof. Nancrede, on reflecting the flap covering the trephine hole, found it filled by the tensely stretched dura mater, pulsating strongly. A small incision was made through this, but nothing was evacuated. The coma rapidly deepening, an aspirator needle, connected with a vacuum, was passed in at three or four different spots to the depth of ¾ inch, but with no result. Feeling convinced that pus was present, and from the symptoms that it was compressing the ascending frontal and parietal convolutions, Prof. Nancrede proceeded to set a large-crowned trephine in front of and below the first opening, which was slightly behind the fissure of Rolando. Before the skull was half divided both pulse and respiration ceased. The operation being rapidly completed, the dura mater was incised without result. At this moment a large drop of pus oozed up through one of the aspirator punctures. A knife being plunged into the brain substance, from 1 to 2 ounces of pus were evacuated. The patient appeared to be quite dead, but vigorous and prolonged artificial respiration revived him. The next day a hernia cerebri as large as a walnut was protruding from the wound in the dura mater. This increased in size, and broke down, the patient dying on April 4. At the autopsy the left parietal lobe formed an enormous abscess-cavity, the abscess being superficial, and destroying the greater portion of the upper part of the left hemisphere.

TREPHINING† IN FRACTURED SKULL

(Figs. 88 and 89).

The scalp having been shaved and thoroughly cleansed (p. 304), the patient brought under the influence of A.C.E. or chloroform,* unless a condition of unconsciousness renders this unnecessary, the head is supported on sand-bags at a convenient height. The fracture is next exposed, the old-fashioned crucial, T- or Y-shaped incisions being now, when possible, replaced by the semilunar flap of Mr. Horsley.† The incisions should usually go down to the pericranium, and this should be raised by a crucial incision cleanly and regularly off the bone, where it is intended to apply the trephine. If it be needful to operate through the temporal muscle, its fibres must be sufficiently severed and raised with the flaps, it being somewhat more difficult to separate the periosteum here, on account of its thinness in this region, and more intimate adhesion to the subjacent bones.‡ In reflecting the flaps, free hæmorrhage is nearly always met with, especially in the case of the chief superficial trunks and the deep temporal arteries, but this is promptly and easily arrested by the use of Spencer Wells's forceps, which act as most useful retractors, taking up but little room, while at the same time they arrest the hæmorrhage. If bleeding continues from any crack in the bone which may now be found, it will only cease on the elevation of the fragment, or on the exposure of, and the dealing with, any subjacent clot. The fracture being now in view, and it being found impossible to introduce an elevator or pair of dressing-forceps, even after sawing off any projecting angle of bone, the surgeon must decide where to place his trephine. In doing so, he must choose a spot, if possible, clear of a sinus (p. 199) or large branch of the middle meningeal artery (p. 214),§ and one which will at the same time support firmly the pressure needed in the working of the trephine. Thus the pin and the greater part of the trephine-crown are placed on sound bone (Fig. 88), while a small part of the trephine usually overhangs a depressed fragment. But if the surgeon fears that the fragments are in contact with the dura mater, and perhaps injuring it, and that the jarring movement of the trephine coming in contact with one may be pernicious, he will so place his trephine that it rests entirely on sound bone, any intervening bridge being easily cut away. A spot

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* *Intern. Encycl. of Surg.*, vol. v. p. 83.

† It has been already stated that in many cases of depressed fractures, after exposure of the fragments, a pair of dressing-forceps and an elevator may do all that is required.

That the trephine itself is not always needed should be clearly understood, as it is probable that elevation of fragments might often most wisely have been performed had it not been for the absence of a special instrument, wrongly supposed to be essential, or for the dread of an operation of undoubted severity with its necessary laceration of the vascular diploe, and requiring delicacy and skill also.

* I much prefer these anæsthetics, if possible, in cases of trephining, on account of the greater excitement and congestion which are usually associated with ether. But whenever it is possible, and especially when the pulse and breathing are falling, anæsthetics should be dispensed with. Where there is any tendency to drowsiness or coma "the anæsthetist should attempt to secure an analgesic rather than a true anæsthetic state" (Hewitt, *Anæsthetics and their Administration*, p. 54).

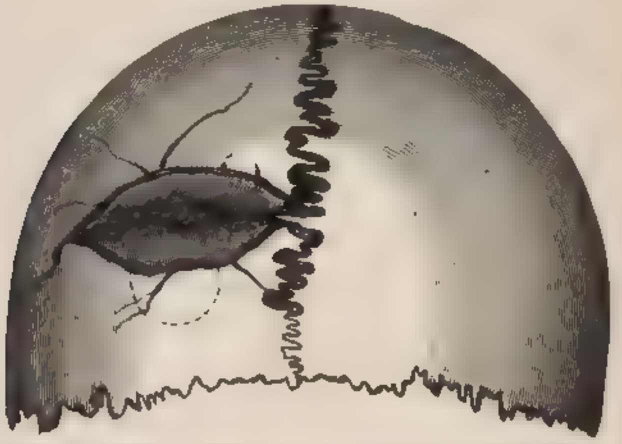
† See below, p. 305. The flap has these advantages:—(1) It is readily detached, and (2) it exposes the bone freely. (3) It allows of more thorough use of antiseptics. (4) It prevents the occurrence of a hernia cerebri.

‡ The greater thickness of the soft parts which will here form the cicatrix will, in a measure, make up for the difficulty in preserving the periosteum.

§ If it is really needful to trephine over one of these vessels, the remarks at p. 215 will show how the hæmorrhage should be met.

being thus chosen, a trephine of appropriate size is taken,[*] with the centre-pin protruded for about a tenth of an inch, and firmly fixed in this position, the trephine being so grasped in the hand that the index finger steadies the centre-pin screw when the bone is entered. The instrument is now firmly applied to the bone, the centre-pin being bored inwards, and as soon as the teeth feel the bone the trephine is worked from left to right and then from right to left, care being taken to exert equal pressure in both directions. While the first groove is being cut, the movements of the trephine must be light and quick, but without jerking, the tendency of the instrument to slip being met by steady bearing on the centre-pin, and by keeping the left forefinger at first on the bone close to the trephine.

FIG. 88.



Compound depressed fracture of "gutter" form. There being no comminution, the trephine has been placed close to, and in part overhangs, the fracture. (Hutchinson.)

As soon as a groove sufficient to keep the trephine steady has been cut, the pin is drawn upwards, and so fixed. The rotatory movements alternating from side to side are now continued, care being taken to bear as evenly as possible on every part of the circle, till the diploë[†] (if this be present) is reached. This is known by the easier working of the instrument, and by the softer sound. On the living body at least, owing to the oozing from the vascular parts around, the blood-staining of the bone-dust described as taking place at this stage is liable to be fallacious.

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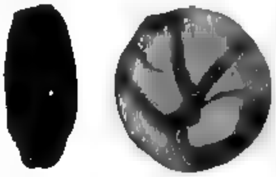
[*] One ¾ inch in diameter is usually ample. The conical trephine is said by American surgeons (*e.g.*, Nancrede, *loc. supra cit.*, p. 96; Dr. Hopkins, *Ann. of Surg.*, vol. ii, No. 7, p. 69) to be safer than the ordinary one, it being almost impossible, owing to its greater steadiness, to injure the brain with it, if, as the deeper part of the internal table is divided, any undue pressure should be made. But if used with ordinary skill, the old form of trephine is perfectly safe. The modified burr of the dental engine has been found to work accurately by some American surgeons—*e.g.*, Dr. Roberts (*loc. supra cit.*)—especially in removing large areas of bone. The use of saws worked by electricity is referred to at pp. 195, 305, Gigli's saws at p. 306, and the forceps of De Vilbiss at p. 308.

[†] This is absent in early life and in the aged. Again, over a large part of the squamous bone and in the occipital fossæ, diploe is never met with. Thus, in cases where the diploe is absent, especially in the thinned calvaria of an aged corpse, it is quite possible, by using haste or force, to jam the crown of bone in upon the brain.

Throughout the operation, but especially now as the thinner table is being reached, every care must be taken to keep the circle of equal depth—(1) by pressing on the saw evenly; (2) by making it bite in equally from right to left and from left to right; (3) by remembering that, owing to the skull being spheroidal in shape, it is impossible, without the greatest carefulness, to keep the groove of equal depth all round; (4) by bearing in mind that while the average thickness of the adult skull is one-fifth of an inch, the thickness varies so much that it is almost always greater at one part of a trephine-circle than at another* (Fig. 89). Thus at frequent intervals the flat end of a trephine-probe, or a quill cut to a point (either being first sterilised), must be carefully introduced at different spots, and when the circle is found to be deeper on one side (still more if it is perforated) the trephine must be so slanted that its teeth are only cutting on that part of the groove which is still shallow. When the groove has been made sufficiently deep, and careful examination finds three or four points of penetration, the bone may be removed by inserting the elevator at the deepest part of the groove and lifting up the disc of bone by carefully making a fulcrum of the sound bone or of a finger.

Fig. 89.



If profuse hæmorrhage occur on raising either the disc of bone or a depressed fragment, it will probably come either from a branch of the middle meningeal artery or from a sinus. The treatment of the former is given at p. 215: in the latter case pressure should be at once applied by means of a pledget of sterilised gauze; if this has to be tucked under an edge of bone to control the bleeding, a ligature of sterilised silk should be fastened on to it, to secure its withdrawal in about three days' time (p. 199).

In the case of a punctured fracture, a full-sized inch trephine should be applied, so as to remove the outer table around the immediate neighbourhood of the puncture, and thus expose freely the damage to the inner table.

If after removing a crown of bone more room is still required, this may be obtained either by taking out a second crown close by, and joining the two, or by the use of a Hey's saw or the forceps of De Vilbiss (p. 308), or of Hoffmann's forceps; if the latter instrument be used it must be of reliable temper.

If the old-fashioned crucial incision has been employed, Mr. West recommends that the periosteum, which should be carefully preserved, should be adjusted with catgut sutures, this precaution tending to prevent any subsequent hernia cerebri. Sufficient drainage must be provided in those cases which require it, *e.g.*, where sepsis is present, or where a large cavity is left under the flap, in which fluid will collect. Any drainage-tube used should be brought through the lowest part of the flap, by puncture if needful, and stitched to the skin.

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* Mr. Holden's words (*Landmarks*, p. 5) are excellent: "Think that you are operating on the thinnest skull ever seen, and thinner in one half of the circle than the other." Sir A. Cooper (*Surgery*, vol. i. p. 188) thus speaks of the operation: "Some people say that this is a trifling operation, not difficult to perform, nor dangerous; but they deceive you: it is one of the most dangerous operations in surgery; whilst performing it there is but a single step—a small network—between your patient and eternity."

With the same view, in order to diminish the subsequent gap, any detached fragments of bone—which should have been kept in hot (T. 105°) bichloride solution, 1 in 3000—may be placed across the aperture in the skull, it having been found by Prof. Macewen* that they will adhere and give no further trouble. Any bone thus used must be rendered absolutely aseptic. If any fragments are too large, they may be cut up with a sharp bone-forceps or chisel. Sufficient drainage is then to be provided by fine tubes or drains of horsehair (a drainage-tube being generally used where the dura mater has been opened, where the brain has been damaged, and in all cases of cerebral abscess), sutures inserted, and dressings applied.

The terse summing up of Dr. Amidon (*Ann. of Surg.*, No. 3, vol. i.) may here be quoted: "Let the operation always be done with antiseptic precautions. Try and secure only proximate coaptation of the flaps. Provide the freest possible drainage. Use cold† antiseptic dressings without much compression. Enjoin the strictest quiet in a posture facilitating drainage."

TREPHINING FOR PUS BETWEEN THE SKULL AND DURA MATER.

While the mode of using the trephine here will in no way differ from that already given, a few practical remarks will be made on this most important condition.

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* *Ann. of Surg.*, Oct. and Nov. 1887. On this subject I would refer my readers to Prof. Macewen's case (p. 123). Where several depressed fragments have required removal, suitable pieces, if sterile, may be replaced if the dura mater be intact. Union may be expected in a fair proportion of cases if the dressings be infrequent (especially in young subjects). The subcutaneous implantation of pliable plates is referred to at p. 230. Mr. Clark (*Lancet*, 1886, vol. i. p. 243), in a case of trephining for traumatic epilepsy, in which this operation was followed by much improvement but not a complete cure, replaced the crown of bone—a piece of the frontal, and the seat of osteitis—after bevelling off the inner edge so as to prevent pressure upon the dura mater, and after cutting a notch in the side of it to serve for drainage. The restored crown did not necrose, but united satisfactorily. However right it may be to replace, in most cases, bone which has been removed, especially in those cases where the removal has been extensive, I doubt very much if this course is judicious in cases of trephining for traumatic epilepsy. Until this subject has been more thoroughly worked out, I think it would be wiser to leave the small trephine-gap not filled up, and thus provide a safety-valve for the relief of varying tension. This course would be especially indicated in cases of long-standing depressed fracture where trephining is resorted to late, and, though the source of irritation is thus removed, the brain has taken an impression, which, though perhaps latent, will remain permanent, and which will be prone to show itself on very slight excitement. See footnote, p. 232.

† Iced boracic acid dressings have been recommended in these cases, but are not reliable, aseptically, in the earlier stages of the wound. Leiter's coil and iced water, a layer of jaconet being placed between it and the usual dressings, is the best way of applying cold in these cases.

It is well known that operative interference here is now less frequent than it would appear to have been a hundred years ago, when Mr. Pott drew the attention of surgeons to the need of trephining when pus was present immediately beneath the skull. For while Mr. Pott, in his day, saved five out of eight of these cases in which he trephined, surgeons of the present time, when they trephine, have been usually baffled by the co-existence of pyæmia, or, if this ominous complication be absent, by finding the collection of pus not localised between the bone and dura mater, or, if so localised, combined with suppurative arachnitis also.

Mr. Holmes (*Treat. on Surg.*, first ed. p. 130) brings forward the following weighty statements: "Some years ago I published (*Brit. Med. Journ.*, Oct. 16, 1858) the experience of St. George's Hospital in this particular for seventeen years—1841 to 1857 inclusive. Eight cases occurred in which the trephine was applied for pus. The pus was found in every case, but all the patients died. Seven were examined after death, and in six of these unmistakable evidence of phlebitis in the sinuses of the brain and veins of the skull and of general pyæmia was discovered. In the seventh case the abscess reached the ventricles of the brain. There were eight other cases in which the trephine was not used, and where matter was found above the dura mater, but it was not limited to this situation in any of these cases, nor would adequate exit have been procured for it by the trephine. In nine other cases there had been intracranial suppuration, but the matter was diffused among the membranes or in the substance of the brain, and lay entirely below the dura mater."

The above most gloomy picture of what has been usually met with only serves, I think, to confirm the opinion given below (p. 208), that these cases should be explored early, being treated, in short, more like cases of acute periostitis and osteo-myelitis elsewhere than has hitherto been the case.

When it is remembered that pus does not form between the bone and dura mater without a previous stage of traumatic osteitis and phlebitis of the veins of the diploë, it will be readily understood how easily, if the wound be foul, septic osteo-myelitis and septic phlebitis, with the inevitable result of pyæmia, will follow.

Indications of the Formation of Pus between the Bone and Dura Mater; Question of Trephining.—History of a head injury with damage of some kind to the outer table. Thus there is often a scalp wound exposing the pericranium, often opening this up at one or two points, perhaps small and not seen at the time; occasionally the bone itself is laid bare by the injury. Either now or later on the wound becomes septic. After a varying period, usually in the course of the second week after the injury (during which period definite symptoms are often absent), headache, fretfulness, nausea, or vomiting sets in, gradually followed by drowsiness, delirium, twitchings, convulsions, paralysis, coma, and death.

This onrush of symptoms about the eighth or tenth day may be accompanied by evidence of pyæmia—viz., rigors followed by sweating, a jactitating temperature, progressive emaciation, and affections of viscera and joints, amongst which pleuro-pneumonia is one of the most frequent and grave.

The surgeon who is watching a case of this kind, and who is also not unmindful of what has happened and what is liable to be going on—the injury to the pericranium and bone, the osteitis and osteo-myelitis with plugging of the diploic veins, the extension to the inner table, the formation between the bone and dura mater of lymph ready to suppurate, this deep-seated inflammation being only too ready to extend to the arachnoid and thus become a diffused meningitis—will find it a matter of much difficulty to answer the questions, How far has the mischief gone? Is the case a hopeless one? If the intracranial collection of pus be a localised one and uncomplicated, well-marked hemiplegia and the absence of pyæmic symptoms will call hopefully for trephining. On the other hand, paralysis, indistinct or complete, epileptiform convulsions, extreme irritability, and, especially, any evidence of involvement of nerves at the base, will all point to that form of meningitis which will show itself as a diffuse layer of pus and lymph over one side of the arachnoid.

Equally pointing to a fatal issue will be the symptoms of pyæmia already alluded to, and needing no further mention here.

What is to be done in these cases? Where the evidence of meningitis is undoubted, of some days' standing, where the hemiplegia has been little marked, or where it is replaced by paraplegia, general convulsions, and other unfavourable signs, no surgeon will be wise in trephining.

Should evidence of co-existing pyæmia be looked upon as equally hopeless and equally negativing the use of the trephine? I scarcely think so. Every surgeon knows that, although pyæmia is usually fatal, it, very occasionally, ends favourably. Again, in treating pyæmia resulting from periostitis and osteo-myelitis elsewhere, we are not deterred from making free incisions and exploring the bone.

The right treatment of these cases must, of course, be really preventive—*i.e.*, every scalp wound should be rendered aseptic and kept so from the very first, however slight it seems to be. But, as this precaution is not always taken, and is occasionally impossible, the condition of the pericranium and bone should be explored earlier, at the very first warning of danger. Instead of treating such a case as a special result of head injury, and waiting for evidence of pus between the bone and dura mater, we should, I think, deal with it as we do with periostitis and osteitis elsewhere; that is to say, that, in cases of this kind where there is reason to believe that the bone has been injured, especially if there be any doubt as to the condition of the wound throughout, the surgeon should, on the first appearance of malaise, irritability, headache, nausea, chilliness, explore the wound. Any granulations here present will very likely be at a standstill. A piece of bone will probably be bare and perhaps soft, the pericranium infiltrated and separating. The whole area of bone which is thus being deprived of its pericranium should be explored and drainage provided. But in nearly all cases, especially if the bone is softened at all, it will be wiser to do more, and open the bone with a trephine to give vent to any inflammatory material in the diploë, to prevent septic phlebitis and its extension to the sinuses, and to save the inflammation from reaching the inner table and dura mater.

The above depends on the fixed conviction that trephining, in careful hands, and with due precautions, is not, in itself, a dangerous operation, and on the fact, which is beyond dispute, that, if these cases are left till hemiplegia pronounces the existence of intracranial pus, they will, too often, be left too long, as this waiting will give time for the onset of pyæmic infection, and for the arachnoid to be involved in the inflammation.

The operation of trephining here will in no way differ from that already described. Pus welling up from the diploic cancelli, or a fetid condition of these, is ominously suggestive of impending pyæmia. If such a condition be present, the bone should be freely removed, and disinfected as far as possible; but, from the probable extension of thrombi to the sinuses, the outlook is a very dark one. If pus be present between the bone and dura mater, it must be thoroughly evacuated, and free drainage provided.* The condition of the dura mater should always be examined into, whether pus be found superficial to it or no. If it pulsate freely and be natural in appearance and devoid of lymph, nothing more need be done. If, on the other hand, it bulge into the trephine-hole devoid of pulsation, it should be punctured, this perhaps giving vent to a jet of purulent fluid from the arachnoid cavity. If the arachnoid is seen to be covered with lymph, this is of the gravest omen. A second trephine-crown may be removed at the most dependent part, the dura mater again opened here, and irrigation employed. The possibility of the existence of cerebral abscess must always be remembered in these cases, where nothing else has been found to account for the head symptoms. The symptoms and treatment are fully given at p. 218.

The following cases are good examples of this most dangerous condition of osteitis of the cranium and its sequelæ and complications:

The first case, reported by Mr. Hutchinson (*Clin. Surg.*, vol. i. p. 97), shows pyæmia prominent rather than arachnitis; the second (*loc. supra cit.*, p. 102), also Mr. Hutchinson's, shows the reverse condition—much arachnitis and no general pyæmic infection. The third, one under my own care, shows both arachnitis and pyæmia combined. In all pus was present between the bone and dura mater.

J. W., aged [illegible], in October [illegible] received a large lacerated scalp wound, a triangular flap of all the tissues of the scalp being torn up from the left parietal bone. The pericranium was not torn up, excepting perhaps at a few points. The boy was admitted into the London Hospital at once, the flap of scalp adjusted, and for some time all went on perfectly well, the boy being kept in bed only for a day or two. *Oct. [illegible].*—While up and at dinner he was noticed to be cold and shivery. A very severe rigor followed. It was impossible to ascertain whether for some days he had had headache or not. In the wound the granulations were pale and glassy, and a small piece of dry, bare bone was exposed. During the next few days there were repeated rigors. *Nov. [illegible].*—He had now very decidedly the signs of pneumonia, and the breathing, temperature, pulse, and cough confirmed this. *Nov. [illegible].*—He seemed better than yesterday, the respiration being more easy. There is not the slightest sign of paralytic weakness. Doubts have been expressed as to whether the boy is or is not the subject of pyæmia. He looks comfortable, excepting for the [illegible] of the [illegible], which is less than yesterday. That he is suffering from [illegible] is almost certain, and that the pneumonia does not produce the usual train of symptoms (no rust-coloured sputum, no great dyspnœa, &c.). If there had been but a single rigor, it is very possible that it might have been indicative only of pneumonia, but their recurrence seems to me to denote pyæmia. This diagnosis is also favoured by the fact of his apparent improvement at times and great variations in condition. The wound was now secreting a very fair quantity of healthy pus. Its granulations were much better than they had been, and fairly florid. During the next three days the thoracic symptoms increased. He emaciated rapidly Consciousness was perfect to the last, and he had neither paralysis nor convulsions All traces of granulation disappeared from the wound. He died November 7. There were very numerous pyæmic deposits in the lungs, liver, and spleen. Beneath the scalp wound was bare and greenish bone the size of a crown-piece. The edges of the wound and the pericranium were loose over a surface as large as the palm of the hand, comprising, in fact, nearly all the parietal bone There was a recent scar in the scalp, crossing the vertex transversely, just above the lambdoid suture; the pericranium here was thickened and inflamed, and the bone on both sides of the sagittal suture here was green. On applying the trephine at this spot, dirty-green, fetid pus exuded on the inner surface of the bone. It must be observed that this portion of inflamed bone extended on each side of the sagittal suture, and that it was under, not an open wound, but a soundly healed one.

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* In these cases, and, in fact, in all [illegible] cases where the discharges are [illegible] and the [illegible] changed less frequently.

E. S., aged 10, was admitted, July 21, into the London Hospital with very extensive laceration of the scalp on the left side, laying bare the parietal bone. During the first few days he seemed to be doing well. July 26.—Bone as large as a crown-piece is exposed, white and dry, above the left ear. July 29.—A strong rigor. July 30.—Wound without granulations, looking glazed July 31.—Very restless. Uses all his limbs at times, but the left ones much better than the right Aug 1.—The skull was trephined in the middle of the exposed bone, 2 inches directly above the left ear The dura mater was covered with yellow lymph. It pulsated pretty freely. On cutting through it about a drachm of thin, purulent fluid jetted out The visceral arachnoid was seen to be covered with lymph. Aug 2.—He still uses his left arm, but never his right hand. When the brain, which bulged, pulsating, into the wound, was pressed back, thin pus ran out in considerable quantity from the arachnoid cavity. His aspect was that of a patient in the very last stage of fever. Death took place on August 3 The bone around the trephine-aperture was dry and green. Everywhere on the left side the parietal arachnoid was concealed by a thick deposit of puro-lymph, whilst everywhere on the right side the membranes were perfectly free from deposit polished and glistening. The superior longitudinal sinus contained puriform fluid. The skull at the seat of injury was discoloured over an extent almost as large as the palm of the hand; adjacent to it were other patches, greenish-yellow, opaque, and non-vascular. There were no pyæmic deposits in the lungs or in the viscera of the abdomen.

E. S, aged 40, slipped while getting off an omnibus, January 22, 1877, and was admitted into Guy's Hospital under Mr. Howse's care with a scalp wound 4 inches long, exposing the right parietal bone Owing to some oversight the wound was not dressed at first antiseptically.* the discharge became offensive, and erysipelas of the scalp setting in, she was transferred to my care on February 1. At this time almost the entire right parietal bone was exposed, owing to sloughing of the pericranium. Incisions were made where needful, drainage-tubes introduced, and in a few days the erysipelas had subsided and the wound was sweet. Feb. 11.—She had a rigor for the first time. Feb. 13.—There was some paralysis of the left side of the face and the left limbs. The temperature was 104° Feb. 15.—The hemiplegia becoming more marked. I trephined through the exposed bone, about 1 inch above the right parietal eminence. Pus was met with in the diploic cancelli On removing the crown of bone, an ounce of thick, foul, greenish pus welled up. The inner surface of the bone was very rough, the dura mater which corresponded to it being covered with velvety granulations. As the dura mater did not pulsate, it was punctured, but without result. The patient became more conscious after the operation, but soon lapsed again into a semi-comatose state. Convulsive seizures of all the limbs, with twitchings of both sides of the face, then set in, and continued till the patient's death on February 17. The parietal bone was found to be dying for a considerable area, the diploë being green and offensive. The pus seemed all removed from the dura mater, but there was suppurative arachnitis over the right hemisphere, reaching up to the falx in one direction and the base in the other, but stopping short of each. There were numerous pyæmic abscesses in the lungs and liver.

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* A precaution on which my colleague habitually insists.

In the following case Prof. Macewen (*Pyogenic Diseases of the Brain and Spinal Cord*, p. 289) was more fortunate. The case was one of intracranial extra-dural suppuration with pachymeningitis, exhibiting "Pott's puffy tumour," and originating in infective bruising of the scalp and deeper tissues, but here the pachymeningitis was fortunately limited and pyæmia absent.

I. R., aged 45, received from the shaft of a cart a severe blow on the left side of the vertex, about an inch from the middle line. He was subsequently able to work for a week without feeling anything wrong except slight pain over the part. Subsequently he felt feverish, the pain, which was of a dull character, increased, and was accompanied by occasional sharp stabs over the vertex. He also had great headache and prostration. There was a distinct puffy tumour over the seat of the former injury. This swelling, the patient declared, came on three weeks after the accident, and after it formed he had some relief from the pain. The primary swelling from the bruising had subsided some weeks before the puffy swelling appeared. On incision the skull was found bare, a small quantity of semi-purulent exudation bathing the bone. The diploic tissue was filled with granulation tissue, which could be traced in small portions penetrating the bone, both through the external and almost through the internal table of the skull, which was dark in colour. Between the internal plate of the skull and the dura there was a considerable layer of freshly formed granulation tissue bathed in purulent exudation. The patient's symptoms quickly disappeared after the operation.

TREPHINING FOR MIDDLE MENINGEAL HÆMORRHAGE* (Fig. 90).

Indications.—When a patient, after receiving an injury to the head, has shown several of the symptoms given below.

It is noteworthy that the injury and amount of violence vary extremely. While most frequently serious, as in falls on the head, the violence may be extremely slight, as when a patient slips going downstairs and strikes the head against the wall, when a boy receives a blow from a cricket-ball, or when a child has a fall of 2 feet 6 inches out of a swing. From this the following conclusions follow naturally:—(*a*) That in the cases of severer violence, laceration or contusion of the brain are, only too frequently, complications; (*b*) Where the violence has been slighter, either no fracture may be present, or, if one be present, it is often only a mere fissure, and may involve the internal table only.

i. *Interval of Consciousness or Lucidity.*—This interval between the stunning effects of the injury or concussion and the onset of compression from the effused blood varies, when present, in length from a few minutes to several hours. In about half the cases it is well marked. In a second class it is but little marked, and may easily be overlooked altogether. In a third and last set of cases this interval is never present at all, owing to (1) The presence of a very large hæmorrhage, producing compression symptoms; (2) Co-existing depression of bone; (3) Co-existing injury to the brain; (4) Drunkenness of the patient.

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* For fuller information on this most important subject, I may, perhaps, refer the reader to an article contributed to the *Guy's Hosp. Reports*, 1886, p. 147.

ii. *Condition of the Limbs as to Hemiplegia, Paralysis, Rigidity, &c.*—Hemiplegia, though well marked in a large proportion of cases, must not be looked upon as essential, and middle meningeal hæmorrhage must not be overlooked because hemiplegia is absent, ill marked, or replaced by some other condition of the limbs. At least, the following seven conditions of the limbs may be met with in middle meningeal hæmorrhage.

(*a*) Hemiplegia present and well marked, the leg or arm, and usually both, when taken up and let go, dropping like those of a corpse. This condition is present in probably one-third of the cases. It is noteworthy that occasionally the hemiplegia is on the same side as that injured, the extravasation taking place on the side opposite to that struck.

(*β*) Hemiplegia present, but little marked. In these cases, which are not uncommon, the extravasation may be overlooked. They fall into at least two divisions. In one the hemiplegia is little marked throughout, due, perhaps, to some power of accommodation on the part of the brain, or to the circulation remaining feeble owing to co-existing shock from the time of the injury to the moment of death.

In another group of cases the hemiplegia is ill marked because of brief duration, coming on as it does in these cases towards the close, together with coma, giving but little warning and leaving but short time for interference.

When there is any doubt as to the existence or degree of hemiplegia, the following tests should be carefully made use of: whether the patient resists on the surgeon attempting to move the limbs; the power of the grasp, if any; the result of a needle-prick; whether the patient moves either of his hands, or which of them, when the cornea is carefully touched, or the cilia gently pulled.

(*γ*) Hemiplegia present, but temporary. A very rare condition, produced probably by the brain being able to accommodate itself to the blood.

(*δ*) Monoplegia, or the paralysis more marked in one limb than the other. A rare condition, as the hæmorrhage generally makes pressure upon all the motor area.

(*ε*) General paralysis. Another rare condition, the existence of which may be explained by a very large clot—*e.g.*, on the left side, rapidly effused and making pressure through the left side of the brain, upon the right as well—or by co-existing extravasation into the brain substance itself.

(*ζ*) Absence of any paralysis. A very rare condition, and one which is, perhaps, due to the blood effused from the middle meningeal artery, finding its way through a fracture in the skull, beneath the scalp. (See footnote, p. 213.)

(*η*) Limbs rigid, convulsed, or twitching. It is only too probable here that, in addition to middle meningeal extravasation, contusion or laceration of the brain substance will be found at more spots than one.

iii. *Condition of the Pupils.*—Whilst this may be various, there are at least three conditions which are most important:

(*a*) If the pupils are natural as regards reaction to light, the compression of the brain is probably recoverable if trephining be immediately performed. Further, it is more likely to be a case of compression only of the brain, without other injury.

(β) If the pupils are insensitive, often at the same time dilated, the compression is probably extreme, and, while trephining is urgently called for, it is less likely that in these cases the brain will recover itself after removal of the clot.

(γ) If one pupil is found widely dilated, the other being natural or contracted in size, and if the dilatation be present on the side of the artery injured, in other words, opposite to the side of the body which is paralysed, it is a rare but most valuable sign, the explanation of which we owe to Mr. Hutchinson (*Lond. Hosp. Rep.*, 1867, vol. iv. p. 29).

Taken with other evidence of middle meningeal extravasation, this condition of the pupil points to a large clot, reaching down into the base and pressing forwards upon the sphenoidal fissure, and thus compressing the third nerve.

iv. *The Pulse.*—This will vary according as the case is one of well-marked, uncomplicated extravasation, or complicated with contusion or laceration of the brain; and, if the concussion stage has been severe, according to the degree to which the heart has recovered from this.

In well-marked uncomplicated compression the pulse will be slower than normal—*e.g.*, 66, 52 and still falling, 42, and usually somewhat full and labouring.

v. *Coma, or Unconsciousness.*—With regard to this, the following points should be borne in mind:

(*a*) The degree of unconsciousness will vary with the size of the branch injured, and the rapidity with which the blood is effused. Where the effusion is rapid and the compression great, the coma may be as deep and complete as in apoplexy. But, in other cases, it will be found that though the coma is apparently deep, this is not really so; thus the patient may moan constantly, or may move his limbs feebly when disturbed.

(β) The commencing coma may be taken for natural sleep, or drunkenness, in which conditions the patient may be allowed to lie till it is too late.

(γ) In a few cases the onset of the coma is deferred till late: its onset is here sudden, its course rapid, and it generally ends in death.

vi. *Respiration.*—This, in well-marked cases, is often stertorous and somewhat slow. In cases where stertor has not supervened to call attention to the existence of compression, other and still graver alterations in the breathing may be present, alterations which are warnings that the end is not far off, and that, in the case of intended trephining, there is no time to lose—viz., catchy, short respirations, cyanosis, and gasping, irregular breathing, ceasing for intervals of ten or fifteen seconds, and then repeated.

vii. *State of Scalp.*—When the history is deficient, or when the signs of compression are not well marked, ecchymosis or contusion of the parietal and temporal regions, giving rise to a pulpy or puffy feel, are of great value. This condition will be especially marked when the hæmorrhage from the middle meningeal artery is finding its way through some fracture into the tissues of the scalp.*

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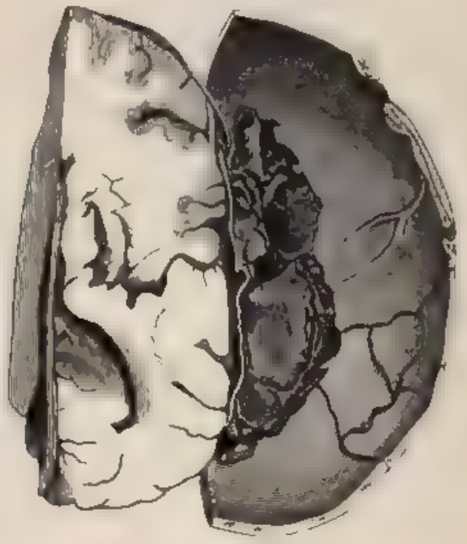
* There is a good specimen of this in St. George's Hospital Museum, Series No. 4,

Treatment. Early trephining should be performed as follows:—The scalp should be shaved widely, for the liberal application of ice, later on, if needful. No anæsthetic should be given if the patient is unconscious, or the respiration failing. The head being supported on sand-bags or a firm pillow, the middle meningeal area on the side which is bruised, and on the side opposite to the hemiplegia, is explored by turning up a semilunar flap, the centre of which is 1½ inch behind the external angular process, and 1 inch above the zygoma—roughly speaking, two fingers' breadth above the zygoma, and about the same behind the external angular process (Fig. 108, p. 275). Kronlein distinguishes, according to the point of rupture, three hæmatomata—an anterior, fronto-temporal; middle, temporo-parietal; and posterior, or parieto-occipital. He advises trephining first at the usual place; if no hæmatoma be found here, a second perforation should be made further back, a little above and behind the ear, or, more accurately, at the intersection of a line drawn backwards from the upper margin of the orbit with a vertical one carried up directly behind the mastoid process. Enlargement of either of these openings will enable the surgeon to deal with a middle or parieto-temporal hæmatoma (*Deutsch. Zeitschr. f. Chir.*,

FIG. 90.



Middle meningeal hæmorrhage with extensive fracture of the skull. Prep 1593^{80}, Guy's Hospital Museum. From the severity of the fracture, which involves both vault and base, such a case gives very little hope

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figured by Mr. Holmes in his *Surgery*, fourth ed. p. 140, Fig 39. It shows the parietal bone of a child, in which a gaping fissure crosses the middle meningeal artery, producing considerable extravasation inside the skull, and still more externally. I have trephined successfully in a similar case. Here, during the half-hour which elapsed between the time of admission and operation, a distinctly increasing swelling was noticed in the scalp of the child.

Bd. xxiii. Hft. 3 u. 4, March 1886). The brisk hæmorrhage which takes place from the scalp will be best arrested by applying Spencer Wells's forceps to the bleeding points, the forceps thus not only arresting hæmorrhage, but acting as retractors also. The pericranium is then carefully separated, and any fissure or fracture looked for on the bone. Whether one be found or no, a crown of bone is next removed with a full-sized trephine. When this has exposed the clot,* hæmorrhage may still be going on, warning of which will, perhaps, be given by the pulsation of the clot. This having been removed by a small lithotomy scoop, one of Volkmann's spoons, the handle of a small teaspoon, or, if soft, better by irrigation, the hæmorrhage may cease, or it may continue profusely, welling up from a point quite out of reach. In such cases, the surgeon may, after saving his patient from the dangers of compression, have to face those of most serious hæmorrhage. In such a contingency, much will depend on the accessibility of the bleeding point, whether it is in the wall of the skull, or in the foramen in the base: the following steps may be made use of: (1) Crushing together with forceps the edge of the bone from which the bleeding comes: (2) If the bleeding spot is found by the aid of a pointed probe to lie in a distinct bony canal, the hæmorrhage may, perhaps, be arrested by plugging this canal with a tiny boiled and aseptic wooden peg:† (3) Forcipressure by means of a pair of Spencer Wells's forceps left *in situ* for twelve hours: (4) Pressure by covering the edges of the wound, first firmly plugged with [illegible] of iodoform gauze wrung out of 1 in 20 [illegible] [illegible] by digital pressure on the common carotid: (5) The worst method [illegible] which is unlikely, ligature of the external or common carotid [illegible] resorted to. If such a step be really needed, a temporary [illegible] of the common carotid [illegible] will perhaps suffice.

Dr. Shepherd of Montreal records (*Brit. Med. Journ.* [illegible] p. 925) a case of middle meningeal hæmorrhage in which ligature of the common carotid was resorted to, and which presents several points of interest. That the hæmorrhage was not [illegible] at first and [illegible] symptoms from the [illegible] spreading [illegible] was not reached until the day after the accident, is explained, in Dr. Shepherd's opinion, by the fact that the rupture of the artery was low down, where the dura mater was closely attached to the base of the skull, and where it needed considerable force to separate it from the bone. In many cases of middle meningeal hæmorrhage the artery is injured higher up, and a clot more readily forms where the dura mater is not so closely adherent to the bone.

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* [illegible]

† [illegible]

‡ [illegible]

[illegible]

A large and very thick clot having been exposed by the removal of two trephine-crowns in the line of a fissured fracture in the anterior part of the left parietal bone, the empty meningeal artery could be seen ramifying on the dura mater, while blood was freely welling up from below. The incision was extended down to the zygoma, the temporal muscle and periosteum pulled aside, and a piece of bone 2 inches wide by 3 inches long chiselled away, in the hope of reaching the bleeding point. After a large amount of clot had been removed, there was furious bleeding from below. The brain and its membranes were held aside with broad retractors, and it was seen that the fracture ran through the foramen spinosum, and then across the body of the sphenoid. The artery was evidently torn in the foramen. It was decided to tie the common carotid. This immediately checked the free hæmorrhage, though venous oozing continued. All the blood-clot having been washed out, the space at the base of the skull was packed with moist iodoform gauze, one end of this being brought out at the lower end of the wound. The patient soon recovered consciousness. Two days later, while the gauze was being carefully removed, "there was a tremendous spurt of blood" as the last piece came away. The wound was therefore again packed quickly with iodoform gauze, which arrested the hæmorrhage. Three days after, the patient had a chill, a temperature of 102·5°, and paralysis of the left side, and motor aphasia set in. These gradually disappeared in another three days, and the gauze was cautiously removed, the last piece without any bleeding, ten days after the date of the second plugging. The patient made an excellent recovery.

Dr. Shepherd considered that the paralysis and aphasia were due to the compression effected by the large quantity of firmly packed iodoform gauze (*vide* p. 327), and not to ligature of the carotid, for these signs came on only after the second packing and were very temporary in duration. The compression would have been rendered still greater when the gauze became soaked with blood. Dr. Shepherd resorted to ligature of the common carotid instead of plugging the foramen, because this might have separated the fracture in the base of the skull.

As in all operations on the head and brain, where the patient's condition is a grave one, infusion of saline fluid (p. 107) should be resorted to when the artery has been secured.

How far the surgeon should remain satisfied with partial removal of the clot, or proceed to remove the skull, and then the blood, more extensively, must depend on the surgeon's surroundings, the amount of skilled help which he can command, but chiefly on the state of the patient, the size of the clot, and whether the depression in the dura mater begins quickly to pulsate and to rise up. If these last points are in doubt, there should be no hesitation, the condition of the patient admitting of it, in removing more bone (p. 305), and any clot which seems firm and dense, till all cause of depression in the membrane is removed.

Prognosis.—With reference to this point, I may quote the following remarks from my paper in the *Guy's Hospital Reports*, vol. xliii.:

"The chief points on which this depends are, whether the middle meningeal extravasation is probably complicated with such injuries as extensive fractures and brain injury, and, secondly, upon the date of trephining, and whether, at this time, the brain recovers itself quickly or not. With regard to the former, or the existence of complications, the surgeon will, if asked to state the probable result, base his opinion on the history of the case, the severity of the violence, *e.g.*, height of fall, whether any interval of lucidity has been present, and, if so, for how long and how far this has been well marked, how far the symptoms of compression, well-defined hemiplegia, the falling pulse, the stertorous breathing, &c., are present or replaced by, or complicated with, those symptoms which are believed to point rather to laceration or contusion of the brain and its membranes—viz., restlessness, convulsive movements or twitchings, pulse quick and sharp, and other evidence of pyrexia, which show that inflammation of the brain has probably supervened upon the injury to its substance."

The seventy cases on which the above paper was based appeared to fall into the three following groups:

A. *The Most Hopeful Cases for Trephining.*—Violence comparatively slight; laceration of middle meningeal artery or its branches; fracture of skull, if present, slight and localised to one side of skull, *i.e.*, not implicating the base; compression present, but little or no contusion or laceration of brain. Twenty-seven cases.

B. *Less Hopeful Cases.*—Violence greater; laceration of middle meningeal or its branches; fracture implicating middle fossa; some injury to brain, but this only trivial. Twenty cases.

C. *Cases probably Hopeless from the First.*—Violence very great; laceration of middle meningeal or its branches; fracture of skull extensive, perhaps implicating several bones and sutures both in the vault and base; injury to brain very severe. Twenty-three cases.

Sub-dural Hæmorrhage.—Where compression of the brain by blood is suspected and none is found superficial to the dura mater, this must be always opened. The following case of Mr. H. W. Allingham's (*Clin. Soc. Trans.*, vol. xxii. p. 220; *Brit. Med. Journ.*, vol. i. 1889, p. 887) is a most interesting one, the bleeding having come, apparently, from a laceration of the frontal lobe.

A man, aged 40, was admitted into the Great Northern Hospital, December 7, having fallen off a tramcar when half-drunk. He complained of pain in the left shoulder; there was no evidence of injury to the head. The next four days the patient was very drowsy, and irritable when disturbed. There was no paralysis. December 13, the patient was seized with convulsions. These began in the muscles of the left side of the face, the mouth being drawn up, and the eyelids moved in clonic spasm. The muscles of the neck were next affected, and subsequently the left arm and leg passed into a state of clonic spasm. The breathing was stertorous. The tongue was not bitten. Chloroform having been given, a curved incision was made from the right external angular to the mastoid process. A large flap having been turned down, a crown of bone was removed over the right fissure of Rolando—*i.e.*, about 2½ inches behind and 1½ above the external angle of the orbit. The posterior branch of the middle meningeal ran across the dura mater exposed. This membrane did not pulsate, and appeared to show a black mass beneath it: the artery being secured, the dura mater was incised and a large black clot exposed. About 3 oz. of this having been removed, partly by irrigation, a large cavity could be felt as far as the finger could reach; the brain appeared to be much lacerated over the frontal lobe. The patient ultimately made a good recovery.

TREPHINING AND EXPLORATION OF CEREBRAL ABSCESS DUE TO INJURY.

Indications for Exploring; Symptoms and Diagnosis of Traumatic Cerebral Abscess.—Many of these are given at somewhat fuller length in reference to that form of cerebral abscess which, as one of the results of otitis media, is discussed at p. 248. To begin with, there is the history of an injury.* If no such lesion as fracture and depression of the skull exists, and if no laceration, &c., of the brain has occurred, there now often follows a latent period devoid of brain symptoms, which may last from a few—*e.g.*, four—days to three or four weeks or much longer.† This latent period is succeeded by brain symptoms increasing in severity and going on to those of compression—viz., headache felt over the side injured, but not necessarily most intense at the injured spot; nausea or vomiting; some pyrexia, although the temperature usually rises slowly, if it rises above normal at all.‡

Other symptoms are mental dulness (the answers long delayed, but intelligent when they come), a slow pulse, perhaps rigors, progressive emaciation, perhaps accompanied by vomiting. Whether local nerve symptoms—*e.g.*, disturbances of sensation and motion—are present must depend on the position of the abscess. If the injury has been over the motor area (Figs. 106 to 111), nerve symptoms may be clearly marked;

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* This may have been a stab with a knife (p. 202), a graze of the head with brief concussion, a fracture, a blow with a stone, a glancing bullet, &c. But the help in the case which the history of an injury gives is not always present, and this is an indication for always examining for any wound or scar, and exploring it, however unimportant it may seem to be, in these cases. Thus, in the following case (Hulke, *Syst. of Surg.*, vol. i. p. 626), the necrosis might have been overlooked, and the fit and rigidity put down to another cause. A middle-aged woman, having fallen down in a fit, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On her right temple was a small festering wound, leading to necrosed bone. On perforating this with a trephine, pus was forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. A large abscess-cavity was found in the anterior lobe of the right cerebral hemisphere.

† As in M. Dupuytren's and Prof. Nancrede's cases at pp. 201, 202; so, too, in a case of Mr. Hulke's, alluded to in a footnote, p. 219, the patient, an errand-boy, continued to work for seven weeks after the injury, more or less headache being present all the time, retching and hemiplegia then coming on.

‡ On this and other points I would refer my readers to p. 248. Prof. Nancrede (*loc. supra cit.*, p. 95) writes thus:—"I believe that an abscess involving the cerebral tissue alone will be accompanied, in most cases, by a subnormal or, at least, a normal temperature. Where a high temperature is noted, either the pus collection is a localised suppurative arachnitis limited by adhesions, or there is a meningitis in addition to the abscess." Prof. Nancrede quotes briefly a case recorded by Dr. H. L. Brown (*Bost. Med. and Surg. Journ.*, Dec. 29, 1881, p. 610) in which the temperature was 97° for eleven days. More rarely, the temperature shows fluctuations, as in a case of Dr. Burney Yeo (*Brit. Med. Journ.*, 1879, vol. ii. p. 84). More rarely still, the temperature continues high throughout.

but if over the anterior part of the frontal, or temporo-sphenoidal[*] lobes, they may be entirely absent. Thus hemiplegia,[†] a paralysis limited—*e.g.*, of upper limb, and, later on, gradually increasing,—epileptic seizures, spasms, spastic rigidity, all have been met with, but must by no means be relied upon; and even when paralysis is present it may escape observation, as when there is slight paralysis of the muscles of the lower half of the left side of the face, and some loss of power in the left hand and arm, but only temporary.[‡]

Finally, the surgeon, who is watching what he believes to be a cerebral abscess, must always remember that after a period of latency, which may last weeks or more, acute symptoms may set in suddenly and quickly close in death.[§]

Operation of Trephining for Traumatic Cerebral Abscess.—As the fatality of cerebral abscess, if left to itself, is so high—90 to 100 per cent.—trephining is abundantly justified, but it must be conducted aseptically for fear of setting up suppurative meningitis and brain-softening. The chief difficulty is, of course, hitting off the seat of the abscess, especially in cases where there are no definite nerve symptoms to guide, and where the history of the part of the head injured is indefinite also. To obviate the necessity of multiple trephining, Dr. Fenger and Dr. Lee, of Chicago, have recommended (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 78), as easier and safer, exploratory puncture and aspiration. This must be done methodically, with a needle, 4 inches long, set in a large-sized hypodermic syringe. The needle should not be too fine, and the gauge should be powerful enough to make sufficient suction, as a fine needle is readily plugged with brain substance. This may be easily taken for pus. The needle, sterilised, is pushed, through a trephine-hole, straight in, in a definite direction, for ½ inch or 1 inch; the piston is then withdrawn a little, and, if no pus follows, the needle is pushed ½ inch further, and the piston again withdrawn. The depth to which it will be permissible finally to push the needle will, of course, vary with the position of the trephine-opening and the direction of the puncture, the surgeon being guided by the anatomy of the brain. The punctures are to be repeated at intervals of ½ inch or 1 inch, the utmost care being taken to push the needle in straight, and to avoid all lateral movements. The loss of resistance, and the sensation that the point moves in a cavity, are to be carefully watched for. If, after a reasonable number of punctures, no pus is withdrawn, the operator may feel convinced that none is present. An abscess in the brain is usually as large as a walnut, often much larger. More details are given at p. 253.

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[*] With regard to the large collections of pus often found here, Dr. Yeo (*loc. supra cit.*, p. 885) quotes as follows from Huguenin (Ziemssen's *Cyclopædia*, vol. xii.):—"The difficulty of diagnosis is increased by the circumstance that no bands of fibres, which are direct conductors of sensibility or motion," pass through this lobe; and, therefore, an abscess here "may attain a considerable size, and may cause general symptoms of compression, before any distinct symptom of local disease arouses the suspicion of a localised affection of the brain."

[†] Mr. Hulke, in relating the case of a boy which he brought before the Medico-Chirurgical Society, March 11, 1879, laid stress on the fact that hemiplegia occurring some time after an injury to the head was significant of disease in the brain itself rather than of arachnitis.

[‡] The value of accurately noting symptoms which, though of but brief duration, may be very important guides in treatment, is well shown by a case of Prof. Macewen's (*Lancet*, 1881, vol. ii. p. 582). A boy, aged 11, was admitted into the Glasgow Royal Infirmary, two weeks after a fall upon his head, with a partially healed wound and bare bone over the left eyebrow. A week later he had a rigor, considered to indicate the probable formation of pus. Five days later, or twenty-six days after the injury, the patient had a convulsion confined to the right side; when this had passed off, he was distinctly aphasic. The seat of the abscess now seemed to be the third left frontal convolution, and trephining was proposed. The friends, however, refused to permit this, as the patient had recovered consciousness, though they were warned that the improvement would be only temporary. Thirty hours later, the convulsions of the right side recurred, the temperature rose quickly from 101° to 104°, and the patient died before the operation could be performed. The situation of the abscess was verified after death.

[§] The sudden cessation of breathing in cerebral cases has been already noticed at pp. 194, 213. So, too, in a case which Mr. Gamgee brought before the Medico-Chirurgical Society, June 14, 1879. A boy, who had been trephined for suspected cerebral abscess, the pus not being found, suddenly ceased breathing the day after the operation. The patient, though apparently dead, having been partly revived by artificial respiration, the dura mater and brain were incised—a step which had not been taken before, as the former structure looked healthy, and did not bulge into the trephine-hole; pus welled up, and the child survived for a week. At the necropsy an abscess 2 inches long, and still containing an ounce of purulent fluid, was found in the right frontal lobe; the abscess had burst externally, causing purulent meningitis.

Puncturing healthy brain tissue with a fine, perfectly aseptic needle can do but little mischief.

The needle should be kept as a guide till the abscess-cavity is definitely opened either by inserting a pair of Lister's sinus-forceps, or a sharp, straight bistoury. The abscess must be thoroughly drained and made to close from the bottom. From an experience of three successful cases, I have not found it so easy to keep a drainage-tube securely in the abscess-cavity as it is to find this (p. 256). The abscess-cavity may be washed out with a lotion of biniodide of mercury (1 in 2000), or one of bichloride solution (1 in 4000); all the fluid injected should be withdrawn.

The following cases of cerebral abscess, in addition to those given at p. 201, and in the footnotes to pp. 218, 219, are good instances of the disease and also of its successful treatment:

A labourer, aged 60, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when headache, which he had had from the time of the accident, became very severe—so severe that his wife feared that he would go out of his mind. On admission the pulse was 56, and the temperature slightly below the normal. The patient's mind was unclouded. About one week later, in the night, he became insensible, and in the morning the right upper and lower limbs were found absolutely palsied as regards motion, and nearly so as regards sensation. When the arm or thigh was severely pinched, he gave scarce any sign of consciousness of it, but shrank slightly when the left limbs were pinched similarly. Two days later, spastic rigidity of the left arm supervened. A small disc of bone cut out beneath the bruised bone on the right temple appeared uninjured. The dura mater bulged up so tensely that pulsation could neither be seen nor felt; its exposed surface appeared healthy. A needle connected with an exhausting syringe was pushed through it to a depth of 1¼ inch. A brownish turbid fluid rose up into the receiver, and continued to flow after the needle was withdrawn. The minute opening was enlarged with a scalpel, and a considerable quantity of fluid escaped. The flaps which had been reflected were replaced, and the wound was very lightly dressed with a little boric charpie. An hour later he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation the charpie was wetted and discoloured by the fluid which continued to ooze, but the wound soon healed, and two months after the operation the patient appeared quite well. (Hulke, *Syst. of Surg.*, vol. i. p. 628.)

It is interesting to note in the following case that the hemiplegia which followed the operation was only transitory. It also shows that grave symptoms may be latent for as long as five months if a skull wound remains unhealed.

A child, aged 4½, had sustained a severe compound fracture of the right frontal bone. The removal of some necrosed portions of bone led subsequently to a slight hernia cerebri. The sinus persisted, but the child seemed well in other respects, until about five months after the accident, when left-sided convulsions (chiefly of the muscles of the face and arm) came on, and an alarming condition rapidly developed. The sinus was opened up and a director passed for a distance of 1 inch into the right frontal lobe downwards and backwards. A free flow of fetid pus occurred, and after the cavity had been washed out with carbolic solution (1 in 40), a drainage-tube was inserted. The latter was removed at the end of a fortnight. Left hemiplegia followed the operation, but it passed off some twenty-four hours subsequently. Recovery was rapid and complete.

TREPHINING FOR EPILEPSY AND OTHER LATER RESULTS OF A CRANIAL INJURY.

This is one of the advances in cranial surgery, the results of which have not come up to the expectations formed of it. The operation, one of the most ancient in the history of surgery, after being almost abandoned for centuries, has been again taken up in the last seventeen years, with all the advantages of modern surgery, especially in those cases where, after an injury, epileptiform convulsions beginning in the leg, arm, or face are due to mischief of the corresponding parts of the motor area. This form of convulsion forms a large part of the epilepsy which bears Dr. Hughlings Jackson's name. I have made very careful inquiry, weighing fairly [illegible] as well as [illegible] and attaching due importance to the fact that many of the failures have not been published, and that most of the [illegible] have been put on record prematurely as to final results— [illegible] —will come to the conclusion that the result of trephining for traumatic epilepsy is a disappointing one.

It will be worth while to go a little into detail with regard to the grounds which have led me to the following conclusion.

Results of Operation.—Large collections of cases [illegible] [illegible] [illegible] have shown that the operation [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] to point out that 2 had not been under observation longer than ten months, a period quite inadequate to allow us to speak with any confidence as to the final result, as in one case of Prof. Agnew's a year, in one of Dr. White's twenty months, had elapsed after the operation before the fits recurred.

From the above statistics Prof. Agnew was of opinion that surgery would do but little for traumatic and Jacksonian epilepsy. He held that the treatment must be mainly preventive. "It is not saying too much to assume that surgery is responsible for the great majority of traumatic epileptics, and though this statement does not by any means criminate the surgeon of an early day . . . . the doctrine that depressed fractures of the skull without symptoms required no operative interference I hold to be responsible for many, very many, of the unfortunate sequelæ of head injuries. However small may be the depression which follows a fracture of the cranium, save in one or two localities, it will encroach enough upon the dural nerves to cause more or less irritation; though insignificant at first and not at all recognisable to the consciousness of the patient, yet eventually that irritation will be propagated to the meninges, and later on to the cortex and brain ganglia, until finally the paroxysmal explosion occurs; and then, even when the initial lesion is removed, the slowly established habit, created by years of excitation, will remain as an ineradicable legacy. No amount of foresight can determine what happens to the inside of the skull, after an injury, by an inspection of its exterior surface. Whenever, therefore, the profession can accept the doctrine that all depressed fractures of the cranium, however slight the depression, and entirely independent of pressure symptoms, are proper subjects for trephining, then will traumatic epilepsy largely disappear from the list of surgical diseases."

Dr. E. G. Mason, of New York, tabulates (*Med. News*, vol. i. 1896, p. 313) 70 cases in a paper which is especially valuable because he refuses to accept any cases as "*cures*" unless the patients have been under observation for three years, and have had no return of fits. Starting with this most sound and wise proviso, he finds 3 cases only (or 8·6 per cent.) can be accepted as cures; 6 (or 8·6 per cent.) showed improvement of more than a year's duration; in 14 (20 per cent.) there was no improvement; in 3 cases death, due to the operation, followed (*vide infra*, Starr). In 38 cases (54·4 per cent.) the period of observation which had elapsed since the operation was not sufficient to justify a decided opinion being given, "though extravagant claims were made in not a few cases."

Another American authority, Dr. Sachs, Consulting Neurologist to Mount Sinai Hospital, New York, working with Dr. Gerster, Surgeon to the Hospital, after a wide experience, came to the same opinion some years ago, and, it is noteworthy, after further opportunities, abides by it. Publishing, seven years ago (*Amer. Journ. Med. Sci.*, Nov. 1892), the results of 9 cases, these authorities stated that the "prospects are rather gloomy," and that "the successful cases will probably be those in which there was some tangible organic lesion which has been removed at a very early period, or those cases in which, after injury to the skull, trephining has been done before the effect of the depression of the skull has resulted in the development of epilepsy." Writing again in the same journal, four years later (Oct. 1896), to record 9 other cases, Dr.

Sachs and Dr. Gerster say that "the experience of later years has taught us that this statement was a just one, and that the views then expressed still hold good; but we have gradually been convinced that if the cases for operation are selected more carefully, and if the surgical *technique* is perfected, the prognosis need not be stated quite so gravely, and that it is possible not only to relieve many, but to cure *some* of the cases of epilepsy." A little later, as a result of most carefully prepared tables, in which the 19 cases are recorded, we are told: "If we were to attempt to give a purely statistical statement we might say that *of the 19 cases here reported, 3 were cured, 2 greatly improved, 3 somewhat improved; while in 11 cases there was absolutely no improvement.* These last 11 cases are equally valuable, however, in showing that partial epilepsies which have existed for a long number of years cannot be cured or improved by any operative procedure."

In 52 American cases collected by Dr. Starr (*loc. supra cit.*, p. 28), 13 being under his own observation, 13 were cured, 11 improved, 15 not improved, and 13 died. Here, also, in several instances, the time that had elapsed between the operation and the date at which the case is reported is quite inadequate.

Starr (p. 112) says as to the result in these cases: "It is evident that in the majority there has been a failure to permanently cure epilepsy by operative interference. When we raise the question why the operation has failed, the obvious reply is, that the original condition which gave rise to the fits has not been removed. This is evident from a study of the pathological changes already enumerated. It is, of course, quite possible to elevate depressed bone, to remove a cyst, or to take away any mass of connective tissue or tumour which compresses the brain. But, on the other hand, it is useless to break up adhesions between the dura and pia or between pia and brain, because they will inevitably re-form after the operation. . . . . Fine trabeculæ of connective tissue entering the cortex from the pia, and forming a dense scar tissue in and about the motor cells, give rise to an irritation which can only be removed by the excision of the mass. But excision of such a mass together with the brain, or excision of a softened mass of brain, is inevitably followed by a formation of a connective tissue cicatrix which, in turn, will act as an irritant. . . . . I think the fact that the underlying organic brain disease producing the epilepsy cannot always be eradicated by an operation fully explains the failures which have been recorded by so many observers. . . . . But when it is taken into consideration that in no case is it possible without an operation to determine the exact pathological condition present, and that a certain proportion of the pathological conditions are removable, it is evident that an operation, if not attended with danger, may be reasonably undertaken."

On account of the importance of the subject I give the most matured opinion of another American authority on the surgery of the head, Prof. Nancrede, of Michigan. The cases are three, and well reported (*Annals of Surgery*, 1896, vol. ii. p. 122). In all three a cortical centre was excised, in all three the fits recurred, though in one case two and a half years, and in another somewhat over three years, had elapsed since the operation: "The brief histories related, the remarks made, and the conclusions now to be given have seemed to me only worthy of attention because they are the results of the rather unfavourable experience of a former enthusiast for the removal of cortical centres in epilepsy, and give what is unusual, the closing results, though somewhat unsatisfactory, of cases reported by the operator himself. It is common enough to read of *cures* (?) a few weeks or months after operation, but rarely are the *relapses* recorded years later."

The following are the chief conclusions to which Prof. Nancrede has "somewhat reluctantly been forced":

"(1) Removal of the discharging lesion in cortical and Jacksonian epilepsy can only be regarded as palliative; the operation scar, in all instances thus far accessible to me, in time becoming a new source of irritation. (2) The earlier the operation is done after the disease becomes fully established, the longer will the immunity last; and it is possible that, if trephining is done very early, the operation may in a few instances prove curative, especially if any reliable method can be devised to lessen the extent of the inevitable adhesions between the brain and the membranes.* (3) Removal of the discharging lesion is imperatively demanded as a life-saving measure in those rare cases where the intervals between the fits are so short that the paroxysms are practically continuous. (4) In all cases, especially those characterised by frequent paroxysms, it is an error to permit the early resumption of work. Operation removes only one of the factors productive of epilepsy, but the ready response to stimuli still remains, and can only disappear, if ever, after a prolonged period; therefore careful avoidance of everything which can, either through the mind or body, excite sudden and severe cerebral congestion must be avoided for the longest possible period—for the remainder of life, if possible."†

But while it is authoritatively proved that the value of trephining for traumatic epilepsy has been greatly exaggerated, owing to many operations having been ill-advised, and also, what is less excusable, to premature reporting of "successes," it by no means follows that this operation is to be abandoned. It is to be employed on more careful and more scientific lines. We should be more careful in promising success save in cases of recent date, where there has been time for the changes to occur which, as we have seen, must render recurrence of the convulsions after a time a matter almost of certainty. In other cases it will be only honest not to hold out much hope of cure, but to explain to the patient and his friends that the operation is more or less of an experiment; that its dangers are slight in experienced hands; that while cure in the truthful sense of the word is unlikely, some relief will almost certainly be granted in the number and severity of the fits; that in any headache, &c., from which the patient suffers, it is impossible to state what the amount of relief will be till the parts have been explored: and, having said this, we shall be wise if we leave the decision in the hands of the patient or his friends.

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* These are referred to below (pp. 228, 230).

† The views of the American authorities on the results of surgical treatment of epilepsy have been quite borne out by the experience of Continental surgeons—viz., Bergmann (*Berl. klin. Woch.*, April 22, 1895), Eulenburg (*ibid.*, April 15, 1895), Solly (*Charité Annal. Jahrgang*, xx.).

For, as we know nothing of the actual causation of epilepsy in these cases, so we must rest uncertain as to the relief which a trephine-opening on wide lines may give. If headache or optic neuritis are present, these will be relieved. As to convulsions, we may hope that, in cases which are not of too long standing, the relief to tension may help towards recovery the impaired vitality of cells so delicately constituted as those of the brain. In other cases the opening may allow of the intracranial circulation undergoing fluctuations, to which it is inevitably exposed, without the unstable cortical centres becoming congested and irritated and prone to explosions, as would otherwise be the case.

Condition of the parts which may be met with during the operation, and which may have originally caused the epilepsy.

(1) **The Scalp.**—Shaving often reveals scars known or undiscovered. When operation was again resorted to in this disease, some years ago, it was hoped that tenderness of such scars would be a valuable guide and characteristic of cases to be benefited by operation. Thus, Mr. Walsham (*St. Barth. Hosp. Rep.*, 1883, vol. xix. p. 127) found that, of 82 cases, the scar or spot was sensitive, tender, or painful in 42. Pressure in some caused vertigo, convulsions, rigidity or spasmodic twitchings of certain groups of muscles.* Larger collections of cases have shown that these instances are fewer than was hoped, the share taken in epilepsy by tender scalp scars being a small one.† An instance of these rare cases may be found quoted by Dr. Agnew (*Trans. Amer. Surg. Assoc.*, vol. ix. pp. 16, 17), in which, in a patient operated on by Dr. T. S. Miller with success, a branch of the great occipital nerve was found caught in an old fracture. In 8 out of the 44 cases collected by Mr. Walsham a sinus was present leading down to bare bone.

(2) **The Periosteum.**—This may be found extremely thickened, and very closely adherent to the bone. Excess of vascularity may also be met with. Osteophytic deposits have not been observed.

(3) **The Skull.**—Lesions of all kinds have been present. Depressions, fractures, fissures, are common. From the inner table a spicule or exostosis‡ may project inwards. With regard to these last conditions,

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* It is especially in those cases in which pressure on a tender scar produces convulsive movements on the same side, that the surgeon may be content with removing the scar.

† Dr. T. H. Manley, of New York (*Journ. Amer. Med. Assoc.*, vol. ii. 1895, p. 1017), gives the following warning with regard to these scars: "In many who come to us with these scars on their scalps, no doubt, if we instituted a searching enquiry, we should find, in some of them at least, that they were produced by a fall in an epileptic seizure."

‡ The term exostosis is sometimes applied to the depressed bone: this, when circumscribed and osteophytic, is easily dealt with. An allied condition, rarer, and one much more difficult to deal with, is described by Dr. Echeverria (*Arch. Gén. de Méd.*, 1878, t. ii. p. 533). A conical irregular projection of bone, measuring 2 × 2½ inches, here compressed the dura mater and brain, being situated very close to the superior longitudinal sinus, just to the left of the occipital protuberance. In trephining, the crown entered into this exostosis, the removal of it proving most laborious, the operation lasting three and a half hours. The patient recovered. A case of Kochler's, of Berlin (*Deutsche Med. Woch.*, No. 46, 1889), illustrates a less localised condition. A sword-cut had injured the bone, without depression. Epileptic fits followed in six weeks. About a year later trephining was successfully performed. The dura mater was adherent, the bone much thickened and covered with thorn-like processes pressing on, but not perforating, the

it is very noteworthy that in one of the cases collected by Mr. Walsham though nothing was detected at the operation, a spicule was found, a the necropsy, not far from the trephine hole, this pointing to the advisability of sweeping a probe carefully and with aseptic precautions so a to explore the parts at some distance from the circumference of th opening. Another point which is of great importance with regard t the indications for trephining as given by the state of the skull is this several cases have been recorded which prove that it is not always saf in trephining for epilepsy to rely on the position of a fracture, unless tha fracture coincides very closely with the spot selected for trephining from the character of the fit. Thus, in two cases related by Dr. Star (*loc. supra cit.*, pp. 30, 32), depressed fractures existed, epileptic attack had developed subsequently to them, but the fit, which, in both patients began in the arm, indicated disease in the middle third of the moto area, while the position of the fracture was upwards of two inches awa from this spot.* In another case, where the surgical indication o position of the fracture was put aside in favour of the medical one, o the evidence given by the fits was followed, the latter proved to be th correct one, as on raising the button of bone a splinter from the internal table was found penetrating the dura mater and brain, though at th spot selected there was no evidence of fracture.

(4) **The Membranes.**—Before opening the membranes the surgeon should remember that it is at this stage that danger begins. Aseptic trephining in experienced hands entails no risk, but it is another matte when the membranes are opened and the brain itself is interfered with. The risks of hæmorrhage, sudden cessation of breathing, shock, sepsis, hernia cerebri, have now to be faced. Both the dura and pia mate may be found much thickened, blended with each other and adherent t the cortex. In some cases they form respectively the outer and inne wall of a cyst.

(5) **The Brain.**—When pathological changes are present in the part explored, the cortex may be found compressed or indented, stained, sclerosed or softened. Cysts in the cortex, perhaps the result of old hæmorrhage, are not uncommon lesions,† and are amongst the most

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dura. Before deciding whether any diffuse thickening of the bone is really morbid the varying thickness of the skull in different parts must be remembered. Good illustrations of a blunt spicule from the internal table are given by Dr. Williamson and Mr. Jones (*Brit. Med. Journ.*, vol. ii. 1899, p. 919). Seven months after the operation the fits recurred. An open sinus which had persisted being explored, a small spicule of necrosed bone "projecting downwards" was removed. Up to the last report recovery was complete.

* Such cases emphasise the need of sweeping a probe around the margins of the trephine-hole, so as to explore the neighbourhood thoroughly.

† The following are instances. In the first (Echeverria, *loc. supra cit.*, p. 535) an old hæmorrhage was present. The patient, aged 22, had, ten years before, fractured his right parietal bone. Epileptic fits began six months after the injury, and their increasing frequency was associated with an extreme degree of idiocy, the patient being, on admission, a mere automaton, without intelligence or memory. On the seat of fracture being explored, a kind of pouch was found embracing an old blood-clot. When this was turned out, the hæmorrhage was so free as to require the actual cautery. The intellectual faculties were largely restored by the operation, and the fits were also much reduced in frequency. The death of the patient took place, nearly nine months later, from meningitis, apparently due to exposure to the sun. An autopsy showed that the

hopeful for treatment. As cysts can rarely be removed, their lining membrane should be carefully curetted, wiped over with pure carbolic acid, lightly plugged with iodoform gauze, and drained, otherwise a fresh secretion of fluid and a recurrence of the symptoms is almost certain.* Any blood clot must be removed by curetting or carefully cut away. If old, it may resemble yellowish scar tissue. If the dura has been opened to get at it, the edges of this membrane must be drawn together with sutures, drainage being employed if needful.

Before cutting through thickened membranes, especially if adherent to the brain, the surgeon should remember the following case, which occurred in the experienced hands of Dr. Gerster himself:

> The patient, æt. 17, had been operated on twice before. The epilepsy continuing and the patient being anxious for a third operation, an attempt was made to lessen the tension caused by a scar at the site of the first operation, over the left arm-centre. Cutting through this scar, the surgeon found an enormously thickened membrane between the dura and the scalp. In the attempts to separate adhesions and cut through thickened membrane, excessive hæmorrhage occurred, which it was impossible to check for some time. The patient did not recover from the shock of the operation, and died in collapse three days later.

Dr. Hamilton, of Chicago (*Amer. Jour. Med. Sci.*, 1894, vol. ii. p. 952), when exploring behind the right fissure of Rolando in a patient suffering from headache and blindness of the right eye after an injury, made use of the following manœuvre:

> Finding the cranium and dura healthy, he opened the latter and passed in a loop of silver wire in different directions. On withdrawing it on one occasion a firm coagulum, measuring 3 centimetres in length, was found adherent to the wire. On the second day after the operation, convulsions and spasm appeared in the left arm, together with loss of consciousness. The wound having been opened up, clots were found pressing on the dura mater. These were removed. Vision was quickly restored, and the patient remained quite well a year later.

If nothing be found when the dura is opened, the surgeon may, before deciding to interfere with the brain itself, explore the neighbourhood of the wound within the dura with a blunt-pointed instrument, *e.g.*, a female catheter, sterilised. By this means a clot or cyst, which would otherwise have been missed, may be detected, and dealt with by enlarging the opening.

But even when clots and cysts may seem to have been satisfactorily dealt with, and the fits cease at once, mischief in the brain may co-exist

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clot-containing cavity was in connection with the meninges, and apparently continuous with one of the branches of the middle meningeal artery. In the second, a cyst was also the cause of the mischief. Thus (*Ann. of Surg.*, vol. iii. No. 6. p. 522; *Amer. Journ. Med. Sci.*, April. 1886), after a pistol-shot wound of the skull, about ⅜ inch from the middle line, and 1⅜ inch from the hairy scalp, aberration followed, culminating in marked insanity. On the depression in the forehead being explored by a crucial incision, an opening in the skull was discovered, closed by fibrous material. In the expectation of finding an abscess cavity, the needle of a hypodermic syringe was thrust in here in several directions until the barrel was found to be filling with a serous fluid, all of which was withdrawn, to the extent of about 2 drachms. On emerging from the anæsthetic, the patient was found to have fully regained his mental equilibrium, in which condition he remained five months later, the wound having quickly healed.

* Prof. Kocher (*La Sem. Méd.*, April 12. 1899) has been obliged to prolong the drainage of a cerebral cyst for three years in order to ensure the disappearance of the epileptiform crises.

(especially if the case be one of long standing) and lead to their recurrence (*vide infra*).

The majority of lesions of the brain will, however, be found to be much less amenable to treatment. How varied they are is shown by the following list enumerated by Dr. Starr (*Brain Surgery*, p. 25):

"Any affection of the meninges, whether pachymeningitis or leptomeningitis, of traumatic or syphilitic or tubercular origin; or new growths upon or in the cortex of the brain; or cysts formed as the resul of small circumscribed hæmorrhages, or of spots of softening from embolism or thrombosis of a cerebral artery; or circumscribed encephalitis or sclerotic patches, may act as centres of irritation in the cortex o the brain. The majority of these forms of disease, when exactly localised in a small area, appear to be traceable to traumatism, either to a blow, a fall on the head, or to a fracture with or without depression."

But it is not only the variety of the lesions of the brain which may after an injury, produce Jacksonian epilepsy, that is worthy of careful note; it is their nature which, it appears to me, makes the majority of them recurrent after any operation, however skilfully performed. At first sight hæmorrhages and cysts would appear capable of being dealt with by careful curetting, drainage, &c. (*vide supra*). But going with these coarser lesions there is almost always present some meningo-encephalitis, circumscribed or diffuse. Coen (Ziegler's *Beitr. z. Path. Anat. u. Physiol.*, 1888. Bd. ii. S. 107), van Gieson (*New York Med. Record*, April 24, 1893). Starr (*vide supra*)—the latter especially—have shown the frequency of the occurrence of adhesions between the pia and the cortex, of a chronic degeneration of the pyramidal cells, and of an increase in the neuroglia. The bearing of this on excision of the cortex will be alluded to later (p. 230).

Operation.[*]—To begin with, a painful cicatrix[†] may be freely excised. This may be done with some hope that nothing further in the way of operation will be required in cases where the scar is constantly painful, tender, or hot; where it corresponds to the course of some known nerve; and in any case where the original wound was lacerated, or contused, and slow in healing, and where there is any chance of a splinter of wood or metal being embedded in the scar.[‡]

If it be necessary, as it usually is, to remove a crown of bone, an appropriate semilunar flap (p. 305) must be reflected, with the aseptic and other precautions already given. Hæmorrhage is next arrested, and the flap retracted by Spencer Wells's forceps, the pericranium being carefully turned off the bone, and its condition noted as to thickening and other evidence of old inflammation. The bone being thoroughly exposed, the surgeon must be prepared for the following conditions—viz., the line of an old fracture, necrosis (indicated by a sinus with prominent granulations), hypertrophic sclerosis amounting, in some cases, to eburnation, and, on the under surface, depressed fragments of the internal table, spurs or nodules of bone. Any sequestrum will, of course, be removed. In trephining the surgeon will use the precautions given at p. 205, remembering that here he is especially likely to be dealing with a crown of bone of varying density at different points of its circumference.[*] It must be elevated with particular caution, as a spicule may have made its way through the dura mater and be pressing on the brain.[†]

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[*] During this, the surgeon must be on his guard for the sudden supervention of epileptic seizures or convulsive movements of one limb—*e.g.*, when he is raising a crown of bone much thickened and adherent to the dura mater.

[†] Prof. Briggs (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 116), in a most excellent paper, in which large personal experience throws much light upon the subject, speaks of having had five such cases. After thorough removal of the scar, the wound was left to heal by granulation; in all the attacks were arrested. In one of Dr. Echeverria's cases (*loc. supra cit.*), convulsions, vertigo, &c., were cured by the removal of a small fibroma adherent to the frontal periosteum and supra-orbital nerve. Dr. Starr's opinion (*loc. supra cit.*, p. 68). on the other hand, is much less favourable: "From my experience I consider that true reflex epilepsy from scars in the scalp is a very rare occurrence."

[‡] Dr. Johnson (*Clin. Soc. Trans.*, vol. vi. p. 35) records a case where trismus, facial neuralgia, and paralysis, with a recurrence of epilepsy (the patient, aged 44, had been free from fits for twelve years), were caused by a sharp, angular piece of flint embedded in a painful cicatrix of the cheek, the removal of which was followed by complete recovery.

If the first crown show nothing abnormal, a probe should be gently inserted between the bone and dura mater and carefully swept around, so as to give information of the condition of the inner surface of the surrounding bone. If the crown show changes which are, however, not localised to it, more bone must be taken away, preferably by the forceps of De Vilbiss (p. 308), till all that is thickened and capable of exerting pressure on the brain and its membranes is removed.

If no change can be found in the crown removed, or in the surrounding bone, what more should be done on this occasion? If there be reason to suspect the presence of an excess of cerebro-spinal fluid or of an abscess in the brain, because the symptoms of this condition (pp. 218, 248) are present, or because the dura mater bulges up without pulsation[‡] into the trephine-hole, the treatment should be as directed at p. 251.

Directions as to dealing with any cysts, and how far it is wise to go in attacking thickened membranes, have been given at p. 227. These details of the operation would not be complete without some reference to **the question of excising portions of the cortex where no lesion sufficient to account for the epilepsy has been found more superficially.** This is not to be lightly undertaken. I have already (p. 223) pointed out that Prof. Nancrede, of Michigan, has with great candour recorded three cases in which he took this step; in all the fits recurred, though in one case not for two and a half years, while in another "somewhat over three years" had elapsed. And this candour is the greater as Prof. Nancrede allows that formerly he thought well of this procedure. Dr. Sachs and Dr. Gerster (*loc. supra cit.*) have given this method a fair trial, having employed it in five cases. Their experience leads them to the conclusion that, in epilepsy of long standing, the excision of cortical tissue does no good, and such excision is hereafter to be restricted to epilepsies of short duration. And again: "Since such cortical lesions are often of a microscopical character, excision should be practised even if the tissue appears to be perfectly normal at the time of operation; but the greatest caution should be exercised to make sure that the proper area is removed."

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[*] Free and most embarrassing hæmorrhage may be met with in sawing through altered diploë traversed by large sinus-like venous channels, requiring firm pressure during and after the operation, plugging with a tiny sterilised wooden peg, or crushing the bone together with forceps at the bleeding point (p. 215).

[†] In one case Prof. Briggs (*loc. supra cit.*, p. 106), on elevating the bone, found that a spicule of bone from its under surface had penetrated the superior longitudinal sinus. The hæmorrhage was arrested by pressure, and the patient made a *good* recovery.

[‡] In a case of Dr. Oliver's (*Lancet*, 1887, vol. ii. p. 1183) the dura mater pressed up tensely through the wound. An incision was followed by a few teaspoonfuls of serum containing shreds of fibrin. For a day after, serum amounting to about 2 or 3 ounces continued to escape.

Not only may this step cause severe hæmorrhage, shock, and open the door to sepsis, but it is impossible to see how it can do otherwise than lead to fusing of the scalp membranes and cortex in a scar which will become increasingly dense with time, and bring about "anchoring of the brain," with its grave disadvantages (p. 312), and sclerosis of the cortex, leading inevitably to a recurrence of the trouble. To put it briefly, it seems to me certain that when taking this step the surgeon is almost sure to replace one traumatic epilepsy by another, which, supervening somewhat later, is traumatic also, but in addition, unhappily, surgical as well.*

What is needed is to prevent the adhesion of brain, membranes, and scalp, and at present none of the methods used are reliable. Possibly transplanting a flap of scalp, bone, and membrane might succeed, but such a step is too severe to be undertaken at the close of an operation already severe and prolonged, and if deferred for some days its object would probably be defeated. The use of gold and other pliable metal plates between the dura and the skull will not prevent the formation of adhesions between the dura and brain. A case of Dr. Gerster's proves this. Having removed a cerebral cyst, this surgeon placed a gold plate between the dura and the skull. Two years and nine months after the first operation it was necessary to perform a second, and, while the gold plate was found lying exactly as it had been introduced, the best result attained was "that the surrounding tissue had undergone fewer changes than would have been the case if the ordinary scar had formed." Other materials have been suggested by the ingenuity of American surgeons. Beach has used gold-foil, Abbé rubber-tissue; but these substances have been proved to have the disadvantages of causing formation of adhesions and scar tissue, of disintegrating, and of causing suppuration. Dr. L. Freeman, of Denver (*Ann. Surg.*, Oct. 1898), having tried gold-foil in a case of trephining for cerebellar tumour, and found, three months later, "considerable new connective tissue had formed," recommends the use of egg-membrane, as being inexpensive, readily obtainable, strong in spite of its thinness, and durable, and not in the full sense of the word a foreign body. The above claims are based upon two experiments on animals.†

Another objection to the removal of motor centres (except, of course, in cases where they are involved by a growth) is that this step may merely replace one inconvenience by another. It is true that in most cases the loss of power has been temporary, but in some this has not been the case. Certainly not every patient would choose to lose his epilepsy at the cost of having a right arm or leg permanently paralysed.

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* After mere incision of the dura or meninges, the cicatrix left will, no doubt, be linear and small, and the inner surface of the skull smooth and adhesions absent, but the condition present after removal of one or more centres will be very different.

† While the interval that Dr. Freeman allowed to elapse in one of his two cases is somewhat short, his method is so simple and easily employed that it deserves a wider trial.

Furthermore, it is easy to understand that in inexperienced hands permanent damage may be readily inflicted on the centres grouped about the motor area, bringing about a condition by which one form of distress will merely be exchanged for another.

If it be decided, owing to the gravity and frequency of the attacks—especially where the condition amounts to the patient being practically in what is a *status epilepticus*—their limitation to one or two centres, the absence of any other extra-cerebral cause, and perhaps also the failure of a previous operation, to remove one of the motor centres, this should be accurately localised by electricity. To trust to measurements of the skull is not enough. Sufficient of the motor area having been exposed, the dura-arachnoid is opened and all hæmorrhage arrested. By means of two aseptic platinum electrodes, different parts of the motor area are examined, the results most carefully noted, and when that spot is reached which causes motion in that particular part of the body first affected in the fit, that particular spot, and that only, should be excised (Keen). Its limits having been determined, any large veins which enter the field of the operation are first tied with fine sterilised catgut passed under them by Mr. Horsley's needle-director. The area of the centre is then marked out by a sharp knife held vertically to the surface and penetrating to the white matter. The centre is then excised by a sharp knife or scissors going to the same depth, about 3 mm., or a quarter of an inch. Hæmorrhage is best arrested by ligature of any bleeding points if possible, hot aseptic lotions, or compression with gauze wrung out of hot lotion. The cautery should never be resorted to if it can possibly be avoided. It introduces sepsis and suppuration, and may lead to a hernia cerebri and blood-poisoning (p. 281). It prevents the surgeon bringing together the flaps of dura mater over the excised centre. Drainage will usually be required on account of the oozing, and will be imperatively needed if the cautery has been employed.

After the removal of the centre, to make sure that this has been effectual, it will be well to again make use of electricity (Keen).

Most strict antiseptic precautions should be made use of before and during the operation; sufficient drainage should be provided, and, in bringing the wound together, the drainage-tube must not be pressed upon or closed. Great care must be taken to keep the wound sweet later on, putrefaction leading to septic softening and hernia of the brain. Only if it has been needful to remove much bone should any of this be preserved and replaced, with the precautions given at p. 206.*

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* Prof. Kocher, of Berne (*La Sem. Méd.*, April 12, 1899, p. 121), is of opinion that not only should the bone disc not be replaced, but that the dura mater itself should be widely excised. He holds that one of the chief causes of epilepsy consists in an exaggeration, local or general, of the intracranial pressure. He believes that, in a number of cases of excision of cerebral centres, except in those where the excision has been sufficiently complete to bring about a definite paralysis, the success should be attributed rather to the opening of the dura mater, which establishes a sort of safety-valve susceptible of regulating the intracranial pressure. In other cases he has seen, after incision of the dura mater, not only epileptiform seizures, but spasms and paresis, disappear. In cases where traumatic epilepsy has been definitely cured he has been able to prove that the site of trephining was filled in by a supple membrane, or showed a loss of substance

In cases where during the operation there has been any escape of cerebrospinal fluid, the dressings will soon need to be repacked or changed.

Causes of Failure after Trephining for Traumatic Epilepsy.—Amongst these are:

1. Not hitting off the right spot.—A bony spicule, undetected at the operation, has been found, at the necropsy, not far from the trephine-hole (p. 225). To meet this contingency, it has been advised to sweep a probe carefully round the circumference of the trephine-hole, and at some distance from it.

2. A general and diffuse thickening of the bone round the site of injury (*vide* p. 229, and footnote, p. 225).

3. Membranes too much thickened and too adherent to the cortex to admit of their being safely detached (p. 227).

4. Owing to the long continuance or to the amount of the irritation, the brain may be permanently affected (*vide supra*, p. 228). Thus, in Dr. Gunn's words already quoted (p. 198), there are cases of depressed fracture in which "the constant irritation has begotten a permanent impression upon the brain and nervous system which remains after the offending point of bone has been removed." The grosser and more localised the lesion, the more speedy will be the relief. As long as the fits are diminished in number and severity, the prognosis is still hopeful. The fits may be very slow in disappearing. The supervention of insanity is, of course, very grave.

5. While marked relief has been given in some cases of violent temper, delusions, and melancholia, whether associated or not with local epilepsy, the same rule holds with the former as with the latter, *i.e.*, if the interval between the injury and trephining has been a long one, the cure is very likely to be imperfect.

6. Neglect of after-treatment, both medical and surgical, but chiefly the former.—Prof. Nancrede's words (*Intern. Enc. Surg.*, vol. v. p. 102) are worthy of remembrance: "The operation, indeed, removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the nervous system, can only disappear with time; and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly, if at all, benefited, whereas judicious after-treatment will sometimes relieve an apparent operative failure." I would also refer my readers to the words of this authority quoted at p. 224. The words "judicious after-treatment" should especially refer to alcohol.

7. Trephining for fits not belonging to traumatic epilepsy in character.—There is no doubt that the glamour of a new operation and "the chance of finding something" have led to this operation being performed in unsuitable cases, which have not been published. It cannot be too strongly laid down that no operation is justifiable in other epilepsies save the Jacksonian, of which so many are traumatic in origin. That is to say that in ordinary idiopathic epilepsy the conditions justifying operation must be of the very rarest. They would be something of this kind: Epilepsy with intense local headache; Epilepsy in which, after

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capable of acting as a safety-valve; while in those cases in which a recurrence of the fits took place the membrane was resisting and immobile. Kocher would therefore only put back the disc where a very definite lesion, such as an exostosis or growth, has been removed; in all others the skull should be left open.

the general convulsions, paralysis or paresis of any group of muscles follows. Those who trephine in idiopathic epilepsy because it is impossible always to exclude traumatism in idiopathic cases, or because there is a bare possibility that a hæmorrhage, the origin of irritation, may be met with on the surface of the brain, are likely to meet with disappointment. The following case shows that an exact diagnosis as to the nature of the fits is not always easy. It was one in which Mr. Hulke trephined for "anomalous" convulsive attacks supervening several months after a head injury (*Med. Times and Gaz.*, 1881, vol. ii. p. 85).

The operation, while it did no harm, was useless. Bromide and iodide of potassium having been tried in vain, a full trial of valerianate of zinc was made, the fits subsiding under this treatment. This fact, the way in which the fits came on, the slight degree of unconsciousness, its gradual onset, and the fact that occasionally the first convulsion had the aspect of purposive movements, supported the view that the fits were not epileptic but hysterical, induced by the shock of an accident in a person of unstable nervous system. On the other hand, the traumatic origin, the headache, the darting pain on touching the part injured, were all suggestive of some chronic irritative process, and justified the operation of trephining.*

8. A septic condition of the wound, almost invariably the fault of the surgeon, and bringing about (*a*) meningitis, (*b*) hernia cerebri, (*c*) cerebral abscess.

9. Shock.

Finally, in cases of honest doubt, and in those where a well-considered operation has failed, the interference of the surgeon will be justified by the fact that traumatic epilepsy tends to grow worse, and is little affected by medical treatment. In the words of Echeverria (*loc. supra cit.*, p. 225), once declared, traumatic epilepsy, due to injury to the head, leads to early insanity or to feebleness of intellect.

Accidents during the Operation.—Perhaps the fault of the surgeon —viz. (1) middle meningeal hæmorrhage (p. 215); (2) hæmorrhage from an opened sinus (p. 199).

TREPHINING FOR MASTOID ABSCESS AND CEREBRAL ABSCESS, THE RESULTS OF OTITIS MEDIA

(Figs. 91 to 104).

POINTS OF PRACTICAL IMPORTANCE TO THE SURGEON IN THE ANATOMY OF THE PARTS CONCERNED.†

I. *Tympanum.*—(*a*) Roof always thin, not more than a line and a half in thickness, often thinner.‡ Through this, inflammation in otitis media readily reaches the brain, causing meningitis, sub-dural or cerebral abscess. (*b*) Parts of the brain and cerebellum which are in contact with the middle ear. These are the middle and back part of the temporo-sphenoidal lobe, and the outer and front part of the lateral lobe of the

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[*] It is noteworthy that the bone removed and the dura mater being normal in this case, an aspirator-needle was pushed through the latter to the depth of an inch, and then withdrawn, as nothing escaped through it. For a few minutes, owing to the high intracranial pressure, cerebro-spinal fluid spurted in a slender stream for the distance of nearly a foot, and continued to leak away for several hours.

[†] These should be studied together with a skull and one or two sect poral bone.

[‡] The bony roof is occasionally absent.

cerebellum. With regard to this latter site of abscess, Mr. Toynbee held that the greater frequency in adults of thrombosis of the lateral sinus and, with this, of cerebellar abscess was due to the development of the mastoid cells backwards. (*c*) The mucous membrane and the endosteum lining the tympanum are in most intimate contact; hence, in otitis media, caries and necrosis readily occur, especially if the blood-supply to the tympanum from the dura mater is cut off. (*d*) The skin of the external auditory meatus is continuous with the membrana tympani, and thus otitis media may be set up from without, as well as by mischief reaching the tympanum through (*e*) the Eustachian tube, which enters in front, and makes the mucous membrane of the throat continuous with that of the tympanum. (*f*) The outlets of the mastoid cells and of the tympanum are inadequate for drainage in otorrhœa, as many of the mastoid cells lie below the level of their opening into the tympanum, and the floor of the tympanum is, in part, below the orifice of the Eustachian tube. Decomposition, once started, is thus favoured.

II. *Mastoid Cells.*—(*a*) Their development varies with age. In adults, if well marked, they may measure 1½ inch horizontally, 2 inches vertically, and reach quite up to, and even around, the lateral sinus. (*b*) Two groups of cells are present, and their relations are of the utmost importance—A. The upper, or antrum, present both in early and later life, horizontal in direction and closely adjacent to and contiguous with the tympanum; B. The lower, or vertical. These cells are not developed in early life, and vary much in their contents. In only about 20 per cent. do they contain air. The mastoid antrum is of far greater importance. This is a small chamber lying behind the tympanum, into the upper and back part of which (the tympanic attic) it opens. Its size varies, especially with age. Present at birth, it reaches its largest size, that of a pea, about the third or fourth year. After this it usually diminishes somewhat owing to the encroachments of the developing bone around it. Its *roof*, the tegmen antri, is merely the backward continuation of the tegmen tympani. The level of this is indicated by the horizontal root of the zygoma. "The level of the floor of the adult skull at the tegmen antri is, on an average, less than one-fourth of an inch above the roof of the external osseous meatus; in children and adolescents, from one-sixteenth to one-eighth of an inch" (Macewen). The *outer wall* of the antrum is formed by a plate descending from the squamous bone. This is very thin in early life, but as it develops by deposit from the periosteum, the depth of the antrum from the surface increases. Macewen gives the average of this depth as varying from one-eighth to three-quarters of an inch. At the junction of the two parts of the outer wall of the mastoid cells is the masto-squamosal suture, often present at puberty. Through the *floor*, the antrum communicates with the lower or vertical cells of the mastoid. This floor is on a lower level than the opening into the tympanum, and thus drainage of a septic antrum is difficult, fluid finding its way more readily into the lower cells. *Behind* the mastoid antrum is the bend of the sigmoid part of the lateral sinus, with its short descending portion.* The following are Prof. Macewen's directions for exploring this important vessel: "An opening in the bone, with its posterior margin touching a line drawn from the parieto-squamo-mastoid junction to the tip of the mastoid, and drawn within the parallels of the external auditory meatus, will expose the part of the sinus most often affected with thrombosis. The above junction of the asterion is placed about three-quarters of an inch in front of, and half an inch above, the upper part of the posterior border of the mastoid." The sinus lies more superficially than the antrum, being usually one-fourth of an inch, occasionally half an inch, from the surface.

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* Körner, of Frankfort, has shown (*Arch. of Otol.*, vol. xviii., 1889, p. 311) that fatal intracranial diseases (meningitis, sinus-phlebitis, and abscess) more frequently occur

The exact position of the antrum, a little above and behind the external auditory meatus, is represented by Macewen's "supra-meatal triangle." This is a triangle bounded by the posterior roof of the zygoma above, the upper and posterior segment of the bony external meatus below, and an imaginary line joining the above boundaries. "Roughly speaking, if the orifice of the external meatus be bisected horizontally, the upper half would be on a level with the mastoid antrum. If this segment be again bisected vertically, its posterior half would again correspond to the junction of the antrum and middle ear, and immediately behind this lies the supra-meatal fossa" (Macewen). When opening the antrum through this triangle the operator should work forwards and inwards, so as to avoid the sigmoid sinus, while to keep clear of the facial nerve (Fig. 91) he should hug the root of the zygoma and the upper part of the bony meatus as closely as possible, and not continue his perforation more forwards than is absolutely needful. The level of the base of the brain will be a few lines above the posterior root of the zygoma (Fig. 91), and about one-quarter of an inch above the roof of the bony meatus.

In the first few years of life certain points of difference exist in the anatomy of the antrum, which are of practical importance. Speaking generally, the thinness of the outer wall and the presence of the squamo-mastoid suture favour the escape of septic matter to the outside of the skull, while the small degree of development of the mastoid cells also helps to render less frequent intracranial complications at this age, especially thrombosis of the sigmoid sinus. Mr. H. Stiles (*Brit. Med. Journ.*, vol. ii. 1898, p. 1142) points out two more anatomical details which should be remembered. During early life the undeveloped condition of the mastoid process leaves the stylo-mastoid foramen exposed upon the lateral, not the under, surface of the base of the skull. In making the first incision, therefore, by which the soft parts are reflected from the bone, the surgeon should take care, below a point on a level with the middle of the meatus, to make his incision a superficial one only, to avoid injuring the facial nerve. Secondly, the posterior root of the zygoma, which in the adult forms a surface-guide to the level of the roof of the antrum, does not now exist.

The following are all different ways by which sepsis may reach the brain from the ear: (1) Through the roof of the antrum, especially if the bone

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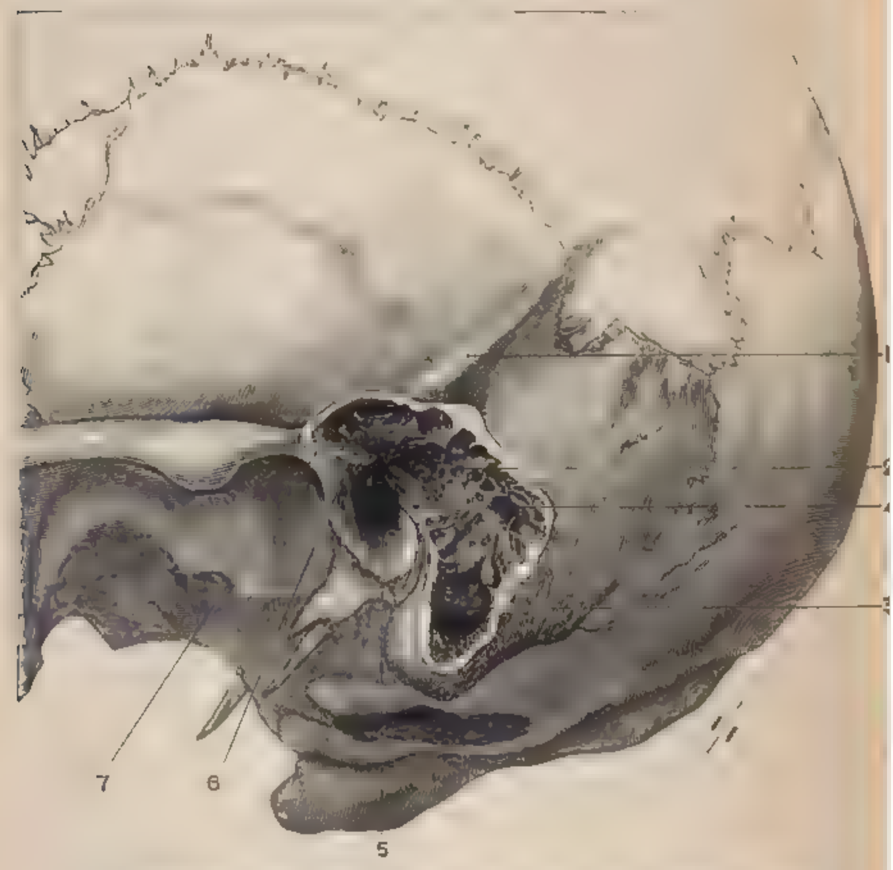
with disease of the right petrous than the left. This is due to the fact that the right lateral sinus, at its sigmoid flexure, comes more forwards into the mastoid and base of the petrous than does the left, and therefore, with its dura mater, lies nearer to the primary disease. This is explained by the passage of blood down into the heart being easier [illegible] re direct on the right side, and this sinus being, accordingly, more be naturally deficient here, into the middle fossa; (2) by the lateral sinus into the posterior fossa; (3) by the labyrinth and internal meatus into the posterior fossa; (4) by the different sutures with their contained processes of dura mater;* (5) the veins which pass from the tympanum

FIG. 91



The outer wall of the mastoid bone, the antrum, attic, and tympanum, together with the posterior wall of the osseous meatus, have been removed here in order to show the field of operation in a case of chronic extensive disease. It will be noticed that the mastoid cells, both horizontal and vertical, are widely developed. 1, Posterior root of the zygoma, forming the upper boundary of Macewen's triangle. 2, Antrum and, in front of it, the attic. 3, Vertical cells of the mastoid. Where these are well developed and become septic, Bezold's mastoiditis (p. 242) will occur. 4, Ridge on the inner wall of the tympanum indicating the Fallopian aqueduct. 5, Fenestræ in the inner wall of the tympanum, indicated in shadow. 6, A natural deficiency in the tegmen enlarged with a small osteotribe to remind my readers how thin is the roof of the antrum and tympanum. 7, Cells present in this case, even in the zygoma at its junction with the middle root. This will show how difficult it is in some cases to bring about complete asepsis.

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* The sutures may be of fatal significance. Thus in cases where there is septic mischief outside the bone, the sepsis having made its way there by an opening in the *mastoid, or, where* this is sclerosed, by dissecting its way along the external auditory

and mastoid cells. These fall into three chief groups: (*α*) those opening into the lateral sinus; (*β*) those passing through the mastoid foramen into the occipital vein and soft parts outside the skull; (*γ*) those running through the petro-squamosal suture to the dura mater. All these veins carry sheaths of connective tissue, and thus inflammatory products may reach (*a*) the lateral sinus, causing septic phlebitis; (*b*) the soft parts outside, causing periostitis, cellulitis, &c.; (*c*) the dura mater and brain, causing meningitis and abscess.

Four Results of Otitis Media which may come under the Notice of the Surgeon.—(i.) Acute inflammation of mastoid cells: mastoid abscess; (ii.) abscess in the brain or cerebellum; (iii.) septic thrombosis of the sinuses and pyæmia; (iv.) meningitis.* N.B.—The above four often co-exist, and thus the symptoms may be much blended together and confusing.

Indications for Interference in Mastoid Disease and Otitis Media.

A. In Acute Cases.—As is stated below (p. 242), a clear distinction must be made between acute and chronic cases. In a very few acute cases, where the surgeon is without skilled help, where the mischief is localised to the mastoid, where the periosteum and soft parts are much involved,† where the patient is young and the parts are yielding, where no evidence of grave septicæmia is present, the surgeon will be justified in making a free incision down to the bone, and enlarging and curetting out any soft patch that he finds in the antrum. But, as a rule, in acute cases the antrum should be freely opened and disinfected (*vide infra*).

B. In Chronic Cases.—Here the decision is sometimes extremely difficult, as the operation, if any be needed, must be an extensive and difficult one.

I consider operative interference called for, in practised hands, in the following cases:—

1. Where, in a chronic case,‡ urgent symptoms pointing to septicæmia or cerebral mischief—*e.g.*, headache, earache, pyrexia, vomiting, dizziness, a rigor, optic neuritis—are present.
2. Where, in a chronic case, there is a history of such grave symptoms as those above given.
3. In obstinate disease of the mastoid. Under this heading should be included—(*a*) Chronic disease of the mastoid with recurrent attacks of swelling; (*b*) Fistula over the mastoid; (*c*) Persistent neuralgia over the mastoid (Schwartze). Whenever the question of a diseased mastoid arises, the apex must not be forgotten (Fig. 91, p. 236).

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meatus, if it reach a suture and its contained process of dura mater, infection of the inner surface and meningitis may easily follow. Schwartze has recorded (*Arch. f. Ohrenheilkunde.* Bd. xxii. S. 295) a case of temporo-sphenoidal abscess in a child, in which infection reached the brain through the petro-squamosal suture.

* According to Poulsen (*Arch. of Otol.*, July 1892, p. 346) the relative frequency of the latter three complications is about the same. Thus, out of 36 cases of complications of otitis media there were 13 cases of abscess, 12 of sinus-thrombosis, and 11 of meningitis.

† I would remind my younger readers that redness, swelling, tenderness, may be very little marked in suppuration in the mastoid, especially if the bone be sclerosed.

‡ Mr. Barker drew attention, some years ago, to the greater gravity of old-standing cases. Thus, otorrhœa does not cause cerebral abscess till it has lasted months or years. In only two of the cases which Dr. N. Pitt collected in his Gulstonian Lectures, 1890, was the duration of the otorrhœa under a year.

4. In cases of long-standing discharge, baffling treatment, but without any severe symptoms. It is these cases which present the most difficulty, if the long duration of the case and the recurrent and rebellious nature of the discharge are the only factors in the case. Here the surgeon will be guided in his decision by the rank of life of the patient, *i.e.*, how far he is intelligent, aware of the grave peril, which may become urgent at any time, and therefore willing to persevere with needful treatment and to keep under regular observation. The nature of the discharge, *i.e.*, the degree of sepsis and its amount when it recurs,* the presence of any persistent bare bone, must be taken into consideration. The age of the patient, whether one entering on the best years of his life, and again whether he is one whose denial of any past evidence of anything approaching to the grave symptoms I have mentioned is to be disregarded, or one who would at once pay attention to any threatening of them, must also be considered.

5. Of course, when cerebral symptoms are present, when these are acute, each operator must decide for himself whether he take the antrum first or no. If the cerebral mischief is not extremely urgent, and if skilled assistance is at hand, the antrum should, if possible, be taken first, so that one operation may suffice. If the operation on the brain is a difficult one, that on the antrum may have to be deferred. When the cerebral symptoms are only slight, *e.g.*, a slight degree of optic neuritis, headache, dulness, &c., it will be justifiable to perform the operation on the antrum first, and to wait and watch carefully. For a slight degree of meningitis may subside after free drainage of the antrum and adjacent parts.

Antrectomy.—Operation based on those of Schwartze and Stäcke.

I am sometimes asked the difference between Schwartze's and Stäcke's operation. The name of Schwartze, of Halle, is associated with the first attempt to put operations on the antrum on a satisfactory footing, he having published, in 1873, a series of cases in the *Arch. f. Ohrenheilkunde*, Bd. vii. u. ix. Replacing such very limited operations as that of Wilde's incision and drilling the bone, Schwartze opened up the mastoid cells and antrum, establishing drainage between these and the tympanum, and keeping the communication open by plugging or a leaden nail. This pioneer operation, though excellent and based on correct principles, admitted of improvement. It was used extensively for many years, with the result that it was found admirably adapted for acute, but insufficient for some chronic cases where the mischief was extensive. Stäcke in 1892 published (*Arch. f. Ohrenheilkunde*, Bd. xxxi.) his operation, which modified that of Schwartze in the following important details —viz., the detachment of the auricle, the removal not only of the outer wall of the antrum but the upper and outer part of the bony meatus, the taking away of the ossicles and membrana tympani, and the replacing of the flaps of the auricle.

I have tried to describe here, with sufficient detail, operative steps which will meet different cases of varying severity. When in doubt as to which operation should be performed, the surgeon will be guided mainly by the amount of disease in the tympanum, the duration of the disease, the condition of the patient, the failure of any previous operation, and the operator's own experience. In recent cases, in those where the disease is limited to the mastoid, often in children, and in those instances where another operation is to be performed at the same time—*e.g.*, for cerebral abscess or sinus-thrombosis—the simpler operation of Schwartze should be employed. If any surgeon decide on performing the less severe, but also less complete, operation, in cases where chronic disease of the tympanum exists, he must remember the consequences of his step. He will relieve his patient especially from the gravest risks, but he will not remove these entirely. He must be prepared for after-treatment often very tedious, with persistent discharge and smell from the meatus, and the troublesome formation of granulations along his operation-track, which obstinately tends to close. This must be kept open (*vide infra*) as long as possible, and the patient must be kept under observation for assiduous, persevering treatment as long as any discharge persists.

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* A discharge may have ceased owing to the formation of a plug of inspissated pus or of granulations. It may be increased by some blow, exposure to cold, the use of instruments, or to some independent pyrexia, of which influenza is certainly one.

The parts having been shaved, cleansed as thoroughly as possible, preferably some hours before, and an anæsthetic (perhaps the best, on the whole, is A.C.E.) cautiously given, a free incision is made with a strong-backed scalpel, starting "above, a little in front of the top of the pinna in the line of the hair. It is carried backwards, and then backwards and downwards, still following the line of the hair till that line passes on to the neck. It is then continued downwards and forwards to the posterior part of the apex of the mastoid. This is a modification of the incision of Chaput" (Ballance). If the parts are inflamed the incision should be very free.* With an elevator or curved blunt-pointed scissors, the auricle is well separated from the bone and pushed well forwards and somewhat downwards, together with the skin lining the meatus, especially at its upper part. Where the parts are succulent with inflammation this step will be easy. Spencer Wells's forceps on the posterior auricular vessels † and other bleeding points will act as retractors, but the auricle will require to be well held forwards, and a very efficient means is a strip of sterilised gauze passed through the meatus and out of the wound, its two ends being knotted and used as a retractor. By this means the bony meatus—especially the part needed, the upper and back part and the supra-meatal triangle of Macewen (p. 235), which is the guide to the antrum—can be defined. Any discoloured patches, opening in the bone, emissary veins, or suture lines are now looked for. If any opening be present it is enlarged. In most cases no such guide is present, and the antrum must be opened through the supra-meatal triangle. This is effected in different ways according to the density of the bone. This may be soft and spongy, or sclerosed, especially in long-standing cases; between the two, varying conditions are met with.‡ If the bone be soft enough, the use of the

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* In a little child the caution given about the exit of the facial nerve (p. 235) will be remembered. As the position of the lateral sinus is so variable—sometimes quite close to the auricle, sometimes only near it, and sometimes well out of danger—it is best to keep close to the auricle. If the surgeon is not only going to open the antrum, but also to explore the lateral sinus, cerebrum, and cerebellum, he will make use of an incision curving backwards so as to raise a flap, as recommended by Mr. Dean (p. 253, Fig. 103).

† Thrombosis of any vein superficially met with will foretell a similar condition in the lateral sinus.

an examination of 100 fresh and 150 macerated specimens Zuckerkandl found gouge (Fig. 92) is best, and will soon effect an entrance through the compact outer layer. But the gouge should be worked with the hand alone as much as possible, and the mallet used with the utmost care and only in removing the outer layer of bone.

Prof. Macewen (*Pyogenic Diseases of the Brain and Spinal Cord*, p. 303) gives the following objections to the use of the chisel or gouge and mallet: 1. "Because, in operating upon a restricted area, surrounded by and full of apertures, some containing delicate structures, the wounding of which may occasion serious and even fatal results, the antrum being situated at a variable depth from the surface, the intervening osseous tissue being of various consistency, it is a source of danger to use a chisel driven by a mallet, which may be suddenly impelled into the interior of one of these spaces, or into the cerebellum, brain, or sigmoid. Such accidents have occurred. During attempts to open the mastoid antrum, the sigmoid sinus has frequently been accidentally opened by the chisel, several of the cases surviving, though a number have died. On one occasion a young surgeon, in endeavouring to open the antrum with a chisel, found, on giving it an impact with the hammer, that the instrument suddenly entered a large cavity, from which pus issued. At the post-mortem examination it was seen that the chisel had penetrated the sigmoid groove, pushed aside the sinus, which was fortunately thrombosed, and entered the cerebellum, from which, on withdrawal of the instrument, pus flowed. 2. Secondly, the repeated blows with the hammer impart considerable vibration to the mastoid and adjoining structures, and when the tegmen tympani or the sigmoid groove is eroded and thinned, the concussion may cause these thinned and friable structures to give way, or cause a rupture of the granulations covering them, and thus permit inoculation of the fresh wounds in the membranes, or in the brain itself. Pus within the brain or cerebellum, receiving through the skull a succession of violent vibrations or shocks, could easily be scattered, or a large abscess near the ventricles or meninges might, by the violent impacts conveyed to it, burst into the ventricles or meninges, thus producing serious if not fatal results." Prof. Macewen prefers the use of drills and burrs worked by an electro-motor. But, as such means are rarely to hand, the surgeon must remember the above warning and use a mallet with much caution.

Mr. Ballance, another authority on the subject, also prefers burrs worked by an electro-motor* (*Med.-Chir. Trans.*, vol. lxxxiii. p. 900). His burrs are of the cross-cut, not the ordinary shape, and 9 mm. and 7 mm. in diameter. He points out that the burr must be kept moist by a

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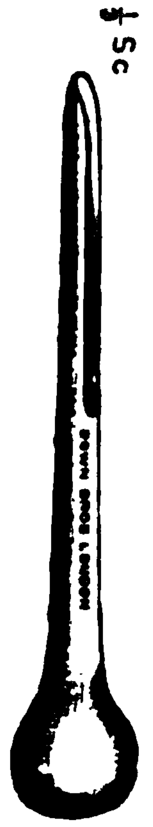
in 20 per cent. an absolute absence of pneumatic cells; 38 per cent. were pneumatic without any diploë. In some cases the upper half only of the mastoid was pneumatic, the lower half containing diploë. Anyone who has seen much of mastoid surgery will agree that no two processes are exactly alike. Sclerosis of bone when present here may be a normal condition; but, whether normal or pathological, it is of importance (1) in adding decidedly to the difficulties of the operation, both by rendering it more difficult to decide when the antrum—which is smaller in proportion to the amount of sclerosis present—is reached, and by making accidents—*e.g.*, injury to the facial nerve—more likely; and (2) in preventing the approach of septic mischief to the surface, and thereby rendering intracranial complications more probable.

* Mr. Ballance's burrs are made by Ash & Co., his electro-motors and accumulators by *Curtis, of Dublin.* The electro-motor and box weigh 25 lbs., the accumulators the same.

stream of antiseptic fluid, and that it must not be pressed against the bone, but kept in constant movement over the area to be removed. The burrs can be fitted with protectors. Where no electro-motor and burrs are available, Mr. Ballance recommends the gouge. For removal of the bone superficial to the antrum he uses sizes 15, 11, and 8 mm. in diameter. The cutting edges should not be curved. He prefers two smaller and longer gouges for removal of the outer wall of the attic, and, while they are in use, Stäcke's guide (Fig. 95) serves to shield the tuberosity which projects from the inner wall into the neck of the antrum (Fig. 91). It contains the Fallopian aqueduct and the horizontal semicircular canal.

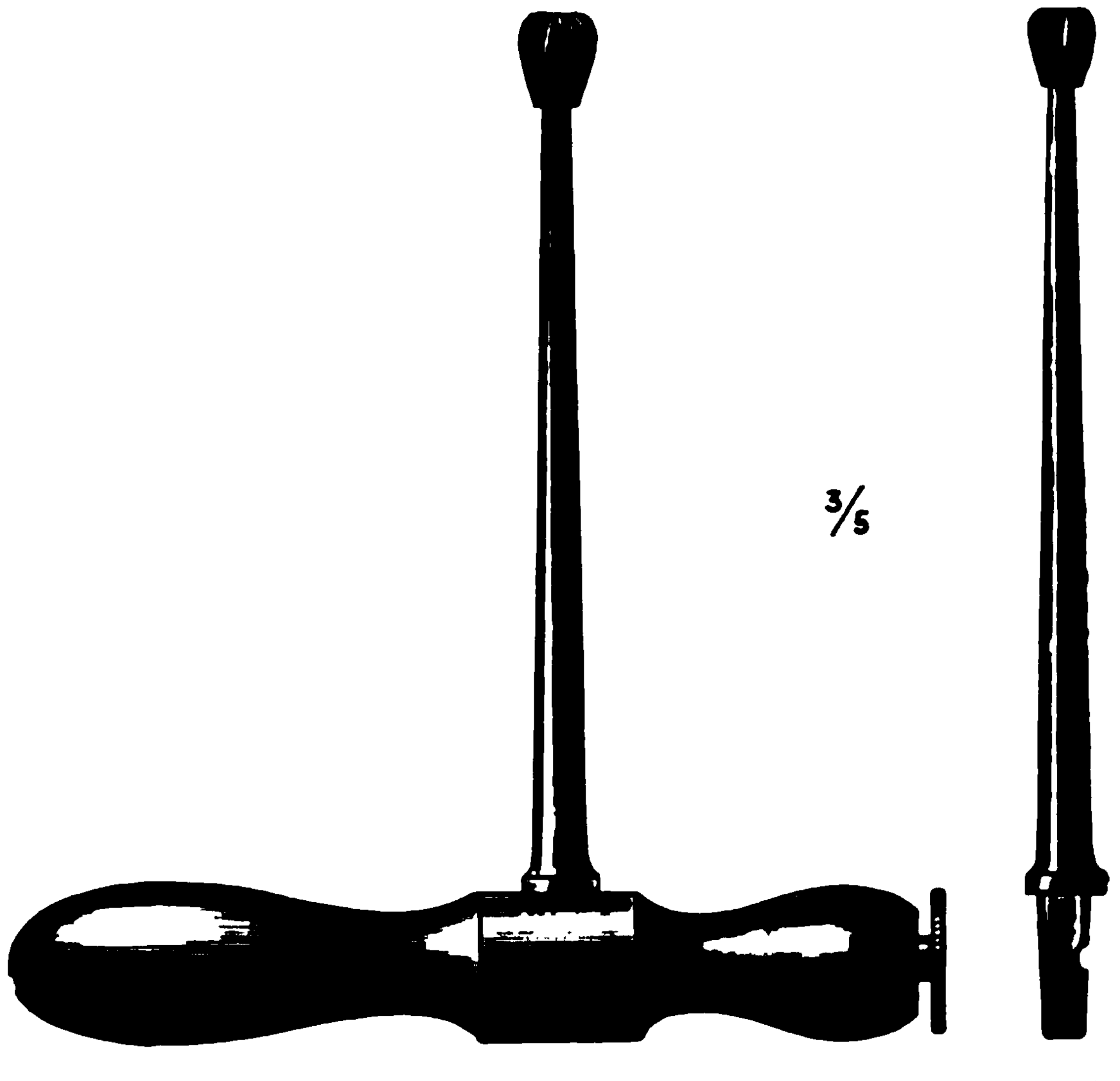
Whatever instrument is employed, it should be directed forwards and slightly upwards, so as to avoid the sigmoid sinus and facial nerve (p. 235). As soon as the compact layer is removed, the gouge and osteotribes, or rose-headed burrs (Fig. 93), will quickly increase the opening. As this is effected, the surrounding surface should also be cut away, cautiously, as it is unsatisfactory and dangerous to work in a cramped, conical, pit-like cavity. As the opening is deepened the surgeon tests whether he has reached the antrum, partly by looking out for any minute dark apertures—*i.e.*, diploic spaces,—partly by examining the fragments he removes for evidence of cancellous tissue, and finally by seeing if he can pass a fine probe along the iter into the tympanum. As the operator goes along, all blood, granulation tissue,* pus, &c., are removed by sharp spoons, dossils of dry sterilised gauze, and, if by

FIG. 92.



Macewen's gouge. This is of the right length to rest safely in the palm of the hand while the point is protected with the forefinger.

FIG. 93.



Osteotribes or burrs, for use with an ordinary trephine-handle.. (Made for me by Down Bros.)

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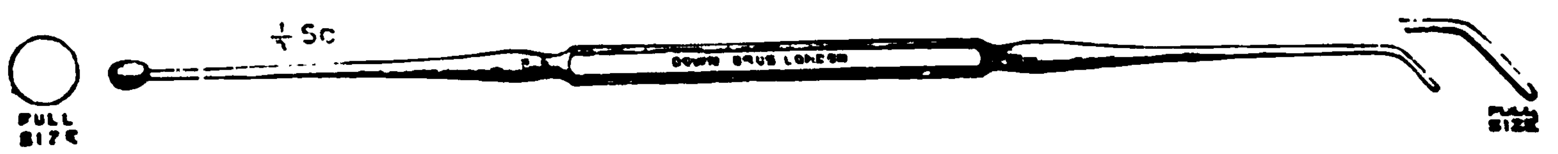
* Prof. Macewen (*loc. supra cit.*, p. 301) gives the following warning as to the importance of buds of granulation tissue: "It frequently happens that granulations springing from the dura lining the cerebellar fossa, and covering the sigmoid sinus, protrude through the sigmoid groove, and project into one of the mastoid cells. When these granulations project in this way from the cerebellar dura, there is a localised pachymeningitis, and probably a more or less thrombosed sigmoid sinus."

irrigation, with the precautions given below (p. 245). In acute cases the operator should also be on the look-out for any pus welling up, and note whence it comes—whether from behind, the neighbourhood of the sigmoid sinus, from in front, the tympanum, or from above, pointing to the middle fossa. Hæmorrhage, usually free and often troublesome, is arrested by pressure with strips of dry sterilised gauze. Occasionally it is profuse, although the instrument used has not been allowed to trench upon the sigmoid sinus; in such cases it may come from a branch of the occipital or stylo-mastoid artery, or from a mastoid vein coming through unusually far forwards. In these cases pressure must be kept up for several minutes, or a small plug of sterilised wood inserted.

The depth at which the antrum may be situated from the surface varies from one-eighth to three-quarters of an inch, or even more. Occasionally it may be absolutely obliterated by hypertrophic sclerosis* (Macewen). The same authority states that he has met with it placed higher up than usual, "somewhat above the level of the outer limit of the floor of the middle fossa, the downward projection of which had to be rounded in order to reach the antrum." He adds that "it is possible, in some of the reported cases in which the antrum could not be found during operation, that it was situated in this manner." Mr. Ballance (*loc. supra cit.*) considers "that it need never happen that the antrum be not reached, as some operators have described, for the attic can always be found, and a bent probe passed backwards from the attic into the antrum will be a sure guide to the exposure of this cavity." Where no antrum can be found, or where one is present but contains no pus, the surgeon should always remember the vertical group of cells (p. 236, Fig. 91) and the apex of the mastoid, in adults. Occasionally cells may be present here and absent above. It is in such cases that Bezold's mastoiditis, with perforation on the inner side of the apex, and suppuration in the digastric fossa and under the sterno-mastoid, may occur.

FIG. 94.



Macewen's combined small curette and seeker. The latter will serve as an ossicle hook.

Having thoroughly dealt with the mastoid cells, the surgeon must decide whether this is sufficient. If it be a recent and acute case, it will be enough to irrigate the cavity with boiled water, carbolic acid lotion (1 in 20), or iodoform emulsion, and then to plug it with sterilised gauze, the wound in the soft parts being only partly drawn together with salmon-gut sutures. But if the case be a chronic one, the tympanic cavity septic and carious, the surgeon must either do more on the lines of a Stäcke's operation given below, or leave his patient to such an operation at a later date, or tedious and prolonged after-treatment. If for any reason, perhaps the condition of his patient, he hold his hand in a chronic case, he should carefully curette the tympanum from the external bony meatus and try and pass a small drainage-tube between the bony meatus and the opening into the antrum. If this step be found impossible,* a stream of boiled water or boracic acid should be syringed between them in both directions, and an emulsion of iodoform and glycerine allowed to trickle into the two openings, or iodoform sterilised in a solution of formalin (1 in 500), or in one of carbolic acid (1 in 20), inserted with a fine curette.

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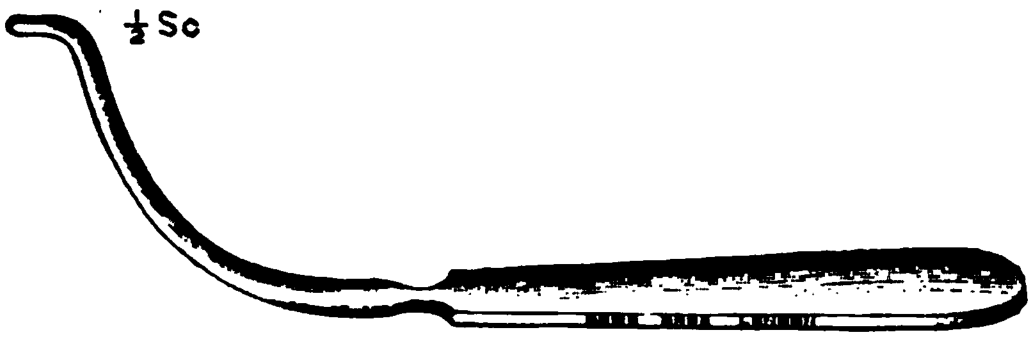
* "When great depth is associated with eburnated bone from sclerosis, the task is a formidable one. If in such cases the sigmoid sinus is situated close to the posterior wall of the canal, the difficulty of reaching the antrum is almost insuperable." Small instruments are absolutely essential here, and it is in these cases that small burrs will be found of great assistance (Barr).

I shall now suppose that the case is one of advanced sepsis spread over a considerable area, a case of long standing, and calling for further investigation on the lines of Stäcke's operation (p. 238). The tympanum next requiring the attention of the surgeon, the entrance into this cavity is identified by a Stäcke's guide (Fig. 95) passed along the iter or attic, then all the bone outside this and the outer and upper wall of the meatus are very carefully cut away with a small chisel or gouge. In effecting this the operator should keep his instrument carefully upwards as well as forwards, and be very careful that it is the outer and not the inner wall of the antro-tympanic passage with which he is dealing, and that he does not descend below the upper part of the posterior wall of the meatus, for fear of injury to the facial nerve.† The anæsthetist should also now carefully watch for any twitchings of the face.

FIG. 95.



Stäcke's guide. (Down Bros.' Cat.)

The following warning of Prof. Macewen (*loc. supra cit.*, p. 300) as to the need of care in dealing with granulations at this stage bears on this point: "Another danger to which the facial nerve is exposed arises when a granulation-mass, protruding through an extensive erosion in the canal, encloses the facial nerve; the surgeon, in clearing the granulation tissue from the floor of the antrum, is apt to injure the nerve. Before removing granulation matter from the floor of the antral passage the granulation buds should be touched with a probe, when, if they enclose the nerve, facial twitchings will result."

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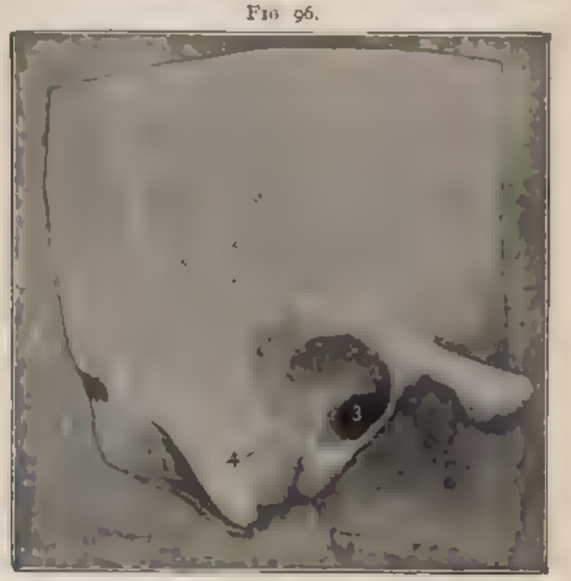
* If the surgeon fail in getting a drainage-tube through, or even in syringing from one cavity to the other, he need not be unduly disappointed. He will have improved the condition of his patient very considerably—a point demonstrated in the large series of cases published by the late Dr. Ferrer, of San Francisco (*Arch. of Otology*, vols. xviii. and xxii.)—but a cure, depending on the amount of sepsis left in the tympanum, can only be brought about by time and assiduous perseverance with the after-treatment.

† Paralysis of the face coming on some hours after the operation is not very uncommon, and is probably due to œdema around the nerve in its canal. It will disappear, though sometimes tediously. This paralysis is especially likely to occur where any natural gap or a pathological erosion exists in the bony canal while the nerve is in relation to the tympanum. If either of the above be present, the neurilemma of the nerve and the mucous membrane of the tympanum will be in close contact with each other.

At this stage a bright light and efficient drying of the parts with dossils of sterilised dry gauze are most helpful. (Ballance.)

Cutting away of the outer and upper wall of the meatus, the outer wall of the antrum and attic, will enable the surgeon to inspect the state of the membranes and ossicles. If the latter are bare of mucous membrane, covered with granulation tissue, carious, or loose, they should be removed, and in all long-standing, septic cases the remains of the membrane and any polypi should be cleared away also. The tympanum, the attic and the antrum, and the external meatus having been thrown into one large cavity, the surgeon examines with a probe for the existence of any outlying cells and pockets with pus; if the vertical group of mastoid cells is developed, and if there be any doubt about their being aseptic, they should be opened up to the apex of the bone, and all intervening and irregular septa opened up with the osteotribe so that the opening is not only large but smooth. Another point which should always be looked into is the roof of the antrum. If a black patch is to be seen above, or if a probe finds a perforation here, this should be carefully enlarged, and the roof, indicated by the level of the posterior root of the zygoma (Fig. 91), carefully trephined or cut away, until the middle fossa is exposed sufficiently to examine the dura mater above the roof of the antrum. This may show a meningitis, local or, too often, part of one diffused, an extra-dural abscess (p. 259), or a sloughy perforation in it may lead to an abscess in the temporo-sphenoidal lobe (pp. 248, 251). The next step is to examine the sigmoid

FIG. 96.

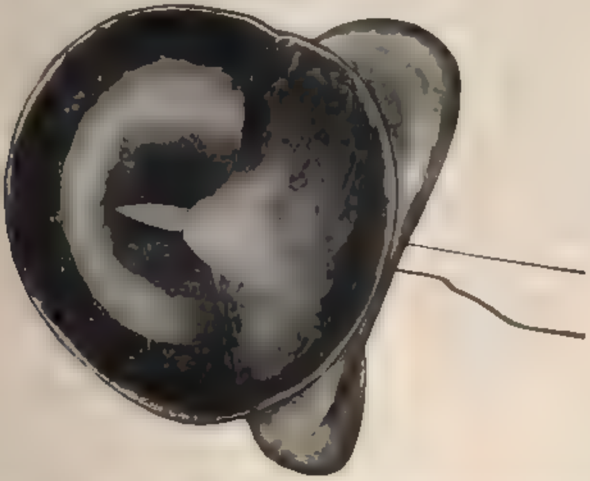


Drawn from a specimen prepared by Hamilton Ballance. The complete mastoid operation has been performed.

1, Inner wall of antrum.
2, Inner wall of attic.
3, Inner wall of tympanum proprium.
4, Ridge of the aqueduct. Under cover of this is the "recessus tympanicus sub-aquæductû Fallopii." The dotted line indicates the backward and upward extension of the recess. (Ballance.)

sinus[*] by removing the bone carefully in a backward direction (p. 257). A dark patch posteriorly may indicate mischief here. Before the surgeon considers the operation completed he should examine again with fine probes for any outlying cells or pockets. The number, size, and extent of the mastoid cells vary in nearly every case, and their disinfection must be carried out thoroughly and efficiently: when the surgeon is in doubt about this he will use emulsion of iodoform in glycerine (10 per cent.), solution of zinc chloride (gr. xx. to ℥j.), or pure carbolic acid. Watery solutions, save a saturated one of boracic acid, should not be run in too freely in case the Eustachian tube is patent; and, for the same reason, solutions of hyd. perch. should not be employed. Incomplete disinfection of the parts, the persistence of a sinus soon becoming fœtid, means an incomplete operation. Again, if the wound heal and tenderness or headache return, a bead of septic pus is probably pent up in some unexplored nook or cell. Having satisfied himself that he has thoroughly exposed and dealt with the whole of the diseased area, it remains to take steps which will ensure the healing of the large wound from the bottom, completely. For some time this was brought about, often incompletely, by plugging the cavity with strips of sterilised gauze, followed, after a time, as the opening contracted—which it was sure to do—by the use of a nail of lead or aluminium (Ferrier). This method of after-treatment was so tedious, so irksome and painful to the patient, it required such perseverance on the part of the surgeon, and such intelligent co-operation from the patient, that it often failed, especially in hospital practice. The following improvements have been suggested: to diminish the large size of the wound, and thus to lessen

Fig. 97.



The posterior edge of the inner extremity of the cartilaginous meatus is shown dislocated outwards, and a long narrow knife has been passed along the length of the meatus through the conchal opening. The white space shown in this and in Figs. 99 and 100 represents the bony area which has been operated on. (Ballance.)

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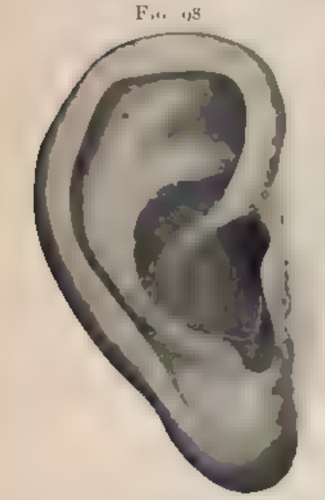
[*] If a healthy, unthrombosed sigmoid sinus has been accidentally opened, the treatment may be that given at p. 199. Unless the neighbouring parts are aseptic this complication is a serious one, owing to the risk of septic phlebitis.

the amount of plugging required, and to prevent any permanent opening being left which would require a subsequent plastic operation. The area of the cavity may be diminished by slitting the cartilaginous canal well out on to the concha, and, at the outer extremity of the horizontal cut, making one at right angles, so as to give a rectangular flap, or by forming two flaps. The edges of the mastoid wound having been brought partly together, without tension, the edge of the upper flap is sutured to this wound at its upper, and the lower flap at its lower, part. This not only covers in the large gap, but it leaves a permanent external meatus of large size (large enough to admit the little finger), which enables the surgeon to scrutinise the wound as it heals, and to prevent any accumulation of pus, granulation material, &c., re-collecting, while it renders a recurrence of the disease very improbable (Bronner, *Brit. Med. Journ.*, vol. ii. 1896, p. 1114).

FIG. 98



The white line here shows the direction of the incision in the concha. The knife is first carried through the concha backwards, and then backwards and upwards till the anterior extremity of the helix is reached. (Ballance.)

The flaps must be kept *in situ* by means of strips of sterilised gauze. If the surgeon have two regions to drain, such as the antrum and the tympanum, one of which is aseptic and the other not, separate deep dressings must be employed. Where there is much oozing, firm pressure, by means of a knotted bandage, will be required. Free hæmorrhage, if dark, a few days after the operation, points to erosion of some sinus, and will generally yield to effective aseptic pressure. Iodoform should not be too long or freely employed, as it tends to encourage granulations. Any of these should be removed by fine curved scissors, a small curette (with the help of cocaine), pure carbolic acid, silver nitrate, chromic acid, &c. As long as the least discharge or smell from the meatus can be detected, the patient or friends must be made to understand that, though he has been brought back from the edge of a precipice, he is still not very far from the brink.

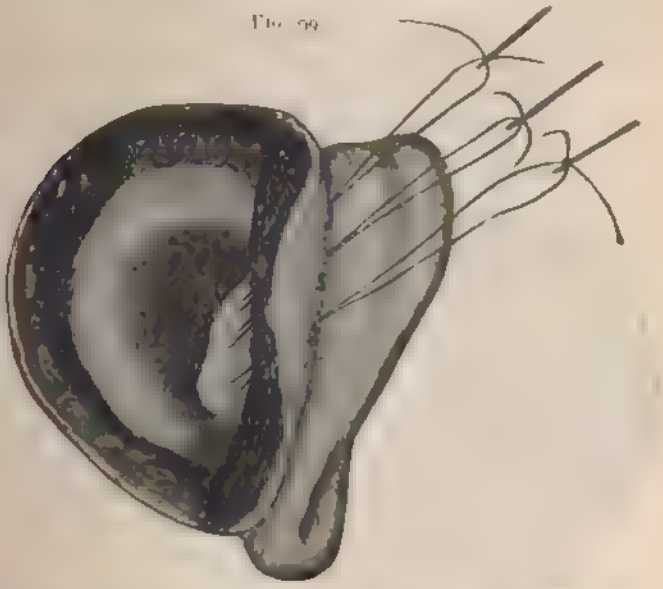
Mr. Ballance (*loc. supra cit.*) adopts a totally different plan of after-treatment, which has been very successful in his hands, and is far superior to the above in point of time, and in saving both patient and surgeon the trouble of the repeated pluggings—a point of much importance in hospital patients and those who are timid. Ten, fourteen, or twenty-one days after the first operation, he covers in all the exposed bone by means of grafts taken by Thiersch's method (p. 188). Mr. Ballance's first departure from the ordinary treatment concerns the cartilaginous canal. Being dissatisfied with the flap method, owing to the difficulty met with in keeping the flaps in place, he pursues the method illustrated in Figs. 97 to 101.

Before the curved wound on the mastoid is sutured, the bony cavity is thoroughly cleansed, dried, and plugged with a narrow strip of iodoform gauze carefully packed against the inner wall of the antrum, attic, and tympanum, the end being brought out through the enlarged meatus. This is changed as often as needed in the interval between the two options. At the end of a week the stitches uniting the curved skin wound will have been removed, but the deep threads holding the meatal flap in position should be left *in situ* as long as possible.

Mr. Ballance's second and most important improvement—*i.e.*, the grafting of the bony cavity—is performed as follows:—Ten, fourteen, or twenty-one days after the first operation, on the morning of the second operation the cavity is washed out with warm sterile saline solution; and this is the only fluid which is used at this operation.

The anæsthetic having been given, the original incision is opened up, and the pinna displaced forwards as in the first operation. All oozing must be arrested with dry sterilised gauze, or the approximation of the graft to the bone will be prevented. A graft is next cut, as thin as possible, in the usual way (p. 188). If practicable, one large enough to cover the whole granulating bony area should be employed. It is best carried to the wound on one of Mr. Ballance's microscopic section-lifters. When the graft, or grafts, have been, by careful manipulation, worked from before backwards, so as to cover and lie flat against the area of the first operation, blood or bubbles of air must be removed by tiny moist pledgets, or the use of Mr. Ballance's steel "stoppers" with pear-shaped heads will greatly facilitate the perfect approximation between the graft and the bony surface. As a protective to the grafts, Mr. Ballance prefers gold-leaf. This is carefully pushed into position, and the cavity plugged with a strip of sterilised iodoform gauze. A week later this

FIG. 59.



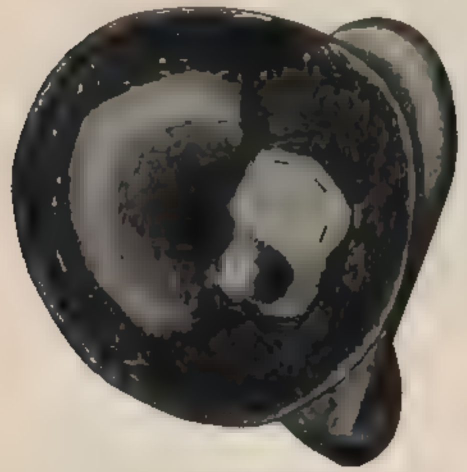
The concho-meatal flap is seen behind the mastoid flap. Supporting stitches (one, two, or three, as the case may be) are carried through the edge of the conchal cartilage. The two threads of each stitch are now threaded on one needle, so that they can be passed through the skin and other tissues of the mastoid flap without constricting them. Before the supporting stitches are passed the thick layer of tissue behind the posterior wall of the meatus is cut away so as to facilitate the application of the meatal to the skin flap. (Ballance.)

is removed, and in another three or four days the gold-leaf is taken out with forceps, aided by gentle irrigation. A little dry sterilised gauze is packed in against the graft, to be changed every two or three days until the healing process is complete.

ABSCESS IN THE BRAIN OR CEREBELLUM.—(A) When in the brain, the collection of pus is usually in the middle and back part of the temporo-sphenoidal lobe; (B) when in the cerebellum, in the front and outer part of the lateral lobe.

Symptoms.—These are often rather negative,[*] no special nerve symptoms being called out in the above regions, as is the case with an abscess in the motor area. There is a history, perhaps, of mastoid suppuration, with the symptoms given above, unrelieved by treatment. A latent period, in which headache, vomiting, and a dull, heavy mental state are usually present, is followed by a more urgent stage. Amongst the most important symptoms of this are agonising headache;[†] drowsiness, deepening into coma; while power of speech remains, the answers are unwillingly given, delayed, but intelligent; "sluggish but perfect cerebration" (Barker, *Lancet*, 1887, vol. i. p. 1177); vomiting (this is occasional, or ceases after a day or two), not constant and incessant; one or two rigors may occur at the commencement of the abscess-formation, but they are not commonly repeated in an uncomplicated case of abscess; the temperature is rarely high in cases uncomplicated with meningitis or thrombosis, often subnormal —*e.g.*, 97°, and falling; the pulse slow—*e.g.*, 65–50; optic neuritis;[‡] progressive

FIG. 100.



The supporting stitches are shown drawn tight, and supporting the raw surface of the concho-meatal flap against the raw surface of the mastoid flap. (Ballance.)

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[*] Dr. Collins, of New York, in an interesting review (*Amer. Journ. Med. Sci.*, April 1890) of the recent literature of the treatment of abscess of the brain, concludes that "the literary records of each succeeding year show that the mortality-rate of abscess of the brain has not fallen as it should have done. This result may be attributed to two factors: first, to lack of early recognition of the disease, apart from its localisation; and, second, to the fact that surgeons are oftentimes not sufficiently assiduous in their search for it."

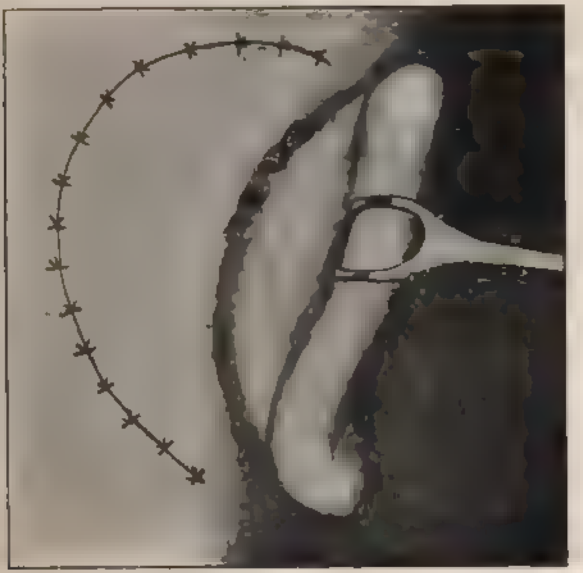
[†] Dr. Pitt (*loc. supra cit.*) considers that the two most characteristic symptoms are "a headache of intense severity, and a dull, sluggish mental state."

[‡] It seems at present unsettled to what condition, thrombosis, meningitis, &c., this symptom is chiefly due. While optic neuritis is certainly met with in abscess meningitis, and thrombosis, it may be present in mastoid inflammation without any cerebral abscess or other known complication save otitis media, and may persist for a long time after the case has been successfully treated by trephining; this occurred very markedly in a case which I was asked to trephine by Dr. F. Taylor in his wards at

emaciation; obstinate constipation. Hemiplegia,* paralysis of face, ptosis, alteration of pupil, are either absent or present only later on. The following symptoms are most grave, and point to a fatal termination being not long delayed viz., lividity, irregular pulse, tracheal râles, pulmonary crepitation, incontinence of excreta, tremors, cervical swelling along the internal jugular vein (p. 257), and, of course, evidence of pyæmia or meningitis, these conditions often co-existing.

Abscess in the Cerebellum.—While the symptoms common to cerebral and cerebellar abscess have been recognised for several years, those peculiar to abscess in the cerebellum have been much less clearly defined. Surgeons have received great help here from an elaborate article by

Fig. 191.



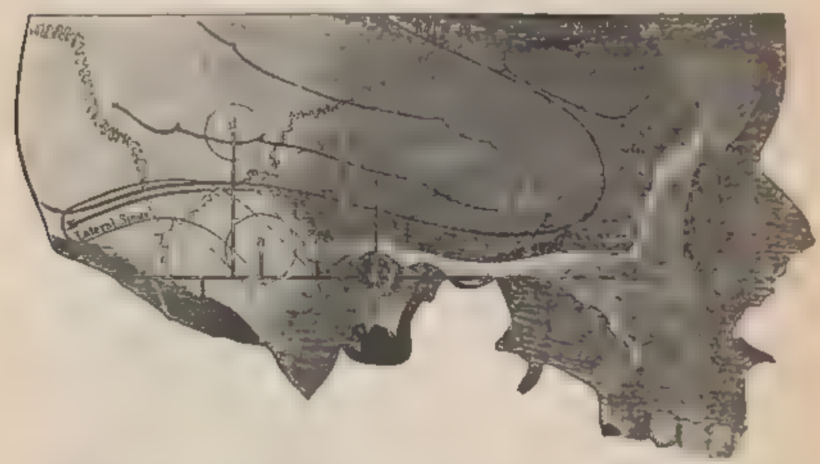
The supporting stitches are shown passing through the angle of junction of the pinna and the mastoid flap. They were two in number in the case from which the drawing was made. They are tied over pieces of rubber tubing. This is shown too small, and the threads are tied too tightly. The curved incision is entirely closed by gossamer silkworm gut sutures. (Ballance.)

Guy's Hospital. Another point is, I think, certain—that if optic neuritis persists after a cerebral abscess has been opened and all seems to be doing well, it is evidence that the cavity is not completely drained. Persistence of the neuritis was a very marked feature in the case mentioned later, in which, after trephining and finding a very large temporo-sphenoidal abscess, I had on two occasions, many weeks subsequently, to let out re-collections of pus. Here it was not until long after the first operation, the wound being now healed, and the patient for some time up and about to leave the hospital, that Dr. Goodall, the medical registrar, reported, "On Aug. 2 (five and a half months after the first operation) there was a little indistinctness of the inner edge of the right disc (the abscess had been on the left side), otherwise both discs were normal."

* I should look upon this as of grave omen, and indicating, perhaps, that the abscess has either burst or is about to do so into the lateral ventricle.

Dr. T. D. Acland and Mr. Ballance (*St. Thomas's Hosp. Rep.*, vol. xxiii. p. 133). The writers throw doubt upon the opinion usually held, that abscess in the temporo-sphenoidal lobe is more common than in the cerebellum. They quote Korner's statistics (*Arch. f. Ohrenheilkunde*, Bd. xxix. 1890, S. 16), showing that in 100 cases of abscess of the brain, secondary to ear disease, 62 were in the cerebellum and 32 in the cerebrum, and 6 in both cerebrum and cerebellum. Of 33 cases collected from the St. Thomas's and the Great Ormond Street Hospitals, 24 were cerebellar and 11 temporo-sphenoidal abscesses. In two cases an abscess was present both in the temporo-sphenoidal lobe and in the cerebellum. In 20 cases the abscess was on the right side, and in 13 on the left (footnote, p. 235). Dr. Acland and Mr. Ballance draw attention to the fact that in their case certain symptoms were present which so closely

FIG. 102.



The figure shows the relations of the lateral sinus to the outer wall of the skull, and the position of the trephine-opening, a, for exploring it. Reid's base line is shown passing through the middle of the external auditory meatus and touching the lower margin of the orbit. x x indicate the site of the tentorium as far as it is in relation to the outer wall of the skull. The anterior x shows the point where the tentorium leaves the skull and is attached to the upper border of the petrous bone. a, Trephine opening to expose lateral sinus, its centre being 1 inch behind and ¼ inch above the centre of the meatus. This opening can easily be enlarged upwards, backwards, downwards, and forwards (see the dotted lines), by suitable angular forceps. It is always well to extend it forwards so as to open up the mastoid antrum, c. b, Trephine opening to explore the anterior surface of the petrous bone, the roof of the tympanum, and the petro-squamous fissure, its centre being situated a short inch above the centre of the meatus. At the lower margin of this trephine-opening a probe can be insinuated between the dura and the bone, and made to search the whole of the anterior surface of the petrous. c, Trephine-opening for exposing antrum, ¼ inch above and behind the centre of the meatus. d, Trephine-opening for temporo-sphenoidal abscess (Barker), 1¼ inch behind and above centre of meatus. The needle should be directed at first inwards, and a little downwards and forwards. e, Trephine-opening for cerebellar abscess, 1½ inch behind and 1 inch below the meatus. The anterior border of the trephine should be just under cover of the posterior border of the mastoid process. Such an opening is well removed from the lateral sinus, and a needle, if directed forwards, inwards, and upwards, would enter an abscess occupying the anterior portion of the lateral lobe of the cerebellum, the usual site of an abscess in this part of the brain. (Ballance.)

resembled the effects produced by removal of one lateral lobe of the cerebellum, that they deserve to be fully considered. These are: i. Paralysis of the upper extremity on the same side as the lesion. ii. Conjugate deviation of the eyes towards the opposite side. iii. Lateral nystagmus. iv. Exaggerated knee-jerk on the same side as the cerebellar lesion. v. A tendency to face towards the side of the lesion in walking. vi. Staggering gait, and a tendency to fall towards the side opposite to the lesion. vii. Attitude in bed: the patient tends to lie on the side opposite to the lesion, with the limbs flexed, and with the side of the face corresponding to the lesion uppermost. The diagnosis of cerebellar abscess is dealt with in the fullest and most helpful way, and the paper deserves the most careful study. Time only will show to how many cases the above-given localising evidence of cerebellar abscess applies, and how far such indications may be further modified by the site, size, and duration of the abscess.

In three cases of cerebellar abscess published by Dr. Green, Professor of Otology at Harvard College (*Amer. Journ. Med. Sci.*, April 1899), paralysis of the extremities was absent in all, and it is stated that "in all of the cases an accurate diagnosis before operation was absolutely impossible." Those interested in this difficult question of diagnosis of cerebellar disease should refer to a masterly paper by Dr. A. Bruce, of Edinburgh, "On the Localisation and Symptoms of Disease of the Cerebellum, considered in Relation to its Anatomical Connections" (*Brit. Med. Journ.*, vol. i. 1899, p. 1079).

Prof. Macewen, in a most instructive case, in which the patient was saved by trephining from the very gravest peril, brought about by a cerebellar abscess, gives the following points as useful in the diagnosis: "The rigidity of the masseters, the very frequent yawning, the mechanical opening and shutting of the mouth, the difficult jerky articulation, the excessive lowering of the circulation and respiration, pointed to a lesion of the cerebellum involving the medulla, while the brachial monoplegia on the same side indicated a lesion below the decussation of the nerve tracks. Blindness is so frequent a sequel of large cerebellar tumours that it also pointed to the location of the abscess as cerebellar, and to one probably of large size" (*loc. supra cit.*, p. 200). At p. 196 the same writer draws attention to the fact that in cases of pressure in the cerebellar fossa, implicating the medullary respiratory centre, the respiration may be gravely imperilled. Further, that cerebellar abscess may cause great ventricular distension and accompanying œdema. A little increase in the above conditions—*e.g.*, when an anæsthetic is given—may easily bring about a fatal result.

Where the diagnosis between a cerebral and a cerebellar abscess still remains doubtful, the only point that should guide us is this: if there is reason to believe that an abscess exists in the brain, the surgeon, on failing to find pus in the temporo-sphenoidal lobe, should not allow the patient to die without exploring the corresponding lobe of the cerebellum.

A. Steps of the Operation of Trephining for Temporo-sphenoidal Abscess.—Any opening in the antrum and the tympanum having been rendered as aseptic as possible, the side of the head having been shaved and sterilised, a semilunar flap of appropriate size is turned up, and the hæmorrhage arrested by Spencer Wells's forceps. Figs. 102 and 103 show the different sites for applying the trephine for a cerebral or a cerebellar abscess.

Prof. Macewen gives the following as the rule for exploring a temporo-sphenoidal abscess:—"The centre-pin of the trephine is placed in a line with the posterior wall of the meatus, and ¾ inch above the posterior roof of the zygoma." Mr. Barker (*Brit. Med. Journ.*, Dec. 11, 1886) thinks that nine-tenths of abscesses in the brain are within a circle with a ¾-inch radius, whose centre lies 1¼ inch above and the same distance behind the centre of the bony meatus. This corresponds to the posterior inferior angle of the parietal bone, and the lower and back part of the temporo-sphenoidal lobe. Owing to the thinness of the bone here the trephine should be used cautiously, the directions given at p. 204 being carefully followed. The crown removed should not show any of the groove for the lateral sinus, nor, if possible, any middle meningeal branch. If the latter is in the way, crossing the dura mater, it should be secured between two catgut ligatures, or the opening in the bone enlarged. The dura mater, if the abscess be of any size, will now bulge forward without pulsation. Prof. Macewen points out, however, that "a small abscess may exist at a deeper level without any diminution of the cerebral pulsation." *

The following directions are from the same masterly pen:—"Before opening the dura it is well to cover the exposed osseous surface and its cut edge with iodoform and boracic acid powder, rubbing it into the cut osseous surface, in order to protect these parts from contamination by the infective pus about to be withdrawn. In incising the dura, commence towards the centre of the opening, when, if any of the piamatral vessels are injured, they can be much more easily secured than if they were cut at the margin of the osseous aperture, beyond which they may retract and bleed into the sub-arachnoid and sub-dural space. In dividing the dura, do not penetrate its whole thickness at once, but pick up its various layers until an opening has been made, when a blunt flat director may be introduced between the dura and the soft membranes, and the remainder of the dural incision completed. A cross-cut may likewise be made, to give freer access to the brain and soft membranes. . . . When there has been lepto-meningitis, accompanied by pachymeningitis, the membranes may all be fused one to another and to the surface of the brain, which will then not impart a sensation of fluctuation, even suppose a large abscess is superficial."

With regard to the three instruments usually employed for the detection of an abscess, the following practical hints are given by the same authority:—"If a hollow needle without a stylet, such as some of those used with an aspirator, be introduced, it will cut the brain substance and become occluded, and if the pressure inside the abscess be small, the occluding brain substance may not be forced out of the hollow needle, and consequently any pus may be prevented from escaping. It is possible that the abscess cavity may be missed if attention be not directed to this point. The introduction of a trocar and cannula will obviate this difficulty, but while being inserted it is liable to transfix a small abscess without revealing the pus, unless the cannula be removed once for each quarter of an inch of brain tissue penetrated. When the sinus-forceps are used the blades are several times gently expanded as they are introduced. The instrument used ought to be inserted in an inward, downward, and slightly forward direction, so as to impinge, if it went far enough, against the cranial aspect of the tegmen tympani. While the instrument is being inserted, a *slight* to-and-fro lateral movement ought to be imparted to its point, with the view of ascertaining whether it has entered a cavity, inside which its extremity can move without resistance." The pus having been detected, it remains to empty the abscess cavity completely. The rate at which the abscess has formed, whether it has a well-marked wall, the degree of sepsis present in its contents, the number and size of any sloughs of brain substance, are all to be remembered here. When the abscess is struck, as is shown by the escape of pus or the bubbling of gas, the opening is enlarged by a small scalpel or by inserting sinus-forceps and opening them. Any sloughs that appear are drawn away, and if the pus is very foul the abscess cavity may be very carefully irrigated with gentle pressure after two drainage-tubes have been inserted, boracic acid or boiled water being introduced very gently by one tube and allowed to flow out by another. As soon as the returning fluid is clear, irrigation should be stopped. Where there are no facilities for irrigation, emulsion of iodoform and glycerine may be injected. Whether tubes of decalcified bone or the ordinary india-rubber ones are made use of, the inner end should be safely lodged just within the abscess, and no more, while the outer one should be secured to the flap, and this so arranged as not to interfere with free drainage. The flaps of the dura should not be stitched together in any case, and where the pus is foul the flaps should be reflected and iodoform gauze wrung out of carbolic acid (1 in 20) should be carefully packed around the opening, to prevent infection of the membranes.

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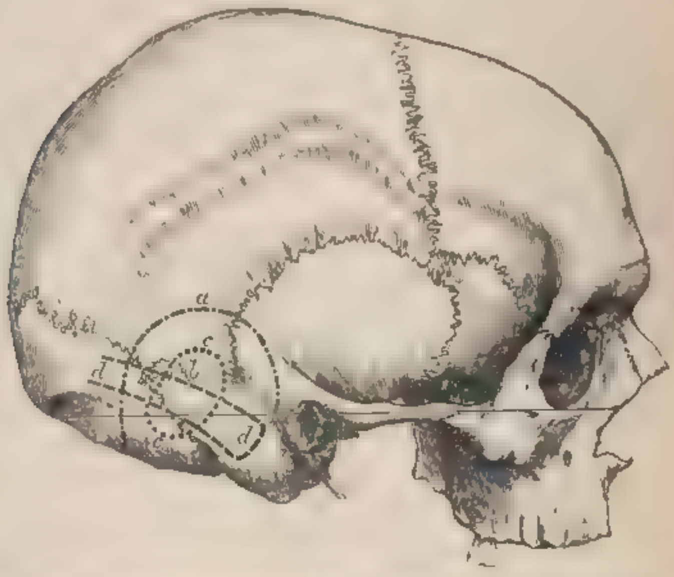
* In some cases the presence of a temporo-sphenoidal abscess has been detected during an operation on the antrum by the presence of a perforation in the roof of this cavity (p. 244), which communicates with the abscess. An abscess thus detected has been occasionally drained by enlarging the opening and dilating the abscess track. Such drainage from the antrum is quite inadequate, especially in large abscesses of rapid growth and without well-defined walls. A second opening should be made into the abscess higher up, in the usual way, and a tube introduced here also. The abscess can then be washed out from the upper to the lower opening.

In some cases where the abscess is large, where sloughs are present, or the pus very thick, much difficulty may be experienced in draining the abscess and in securing its complete obliteration. This is usually due to the drainage-tube being removed too soon. If an india-rubber tube has been employed, this should be replaced at the end of thirty-six or forty-eight hours by a decalcified bone tube; and it may be advisable to employ a series of these, introduced at shorter or longer intervals according to the sepsis or asepsis of the wound, over a period of two or three weeks, in a large abscess (*vide infra*).

To save the risk of serious shock from a second operation, and perhaps a fatal result in an exhausted patient, the surgeon, when in doubt as to the extent of the mischief and the region in which an abscess is situated, should avail himself of the plan recommended by Mr. H. P. Dean (*Lancet*, 1892, vol. ii. p. 250), by which with one flap and one trephine-hole the temporo-sphenoidal lobe, the cerebellum, and the lateral sinus can all be explored (Fig. 103). A semicircular flap of skin just above and behind the ear is turned down, and a periosteal flap then reflected, this flap having a diameter of about 2 inches. The antrum is explored in the usual way, if this has not been already done, the pinna being detached and pushed well forwards. The pin of the trephine is placed 1 inch behind and ½ inch above the centre of the external auditory meatus, and a disc of bone ⅝ inch in diameter removed. The lateral sinus is exposed in the lower part, and the dura mater above, probably bulging considerably. The temporo-sphenoidal lobe can be explored from the upper, and the sinus from the lower part of the trephine-hole. The cerebellum can be next examined by removing the bone backwards and downwards for ½ inch with Hoffmann's forceps, this step exposing the whole diameter of the lateral sinus and the dura mater below it. The latter is then incised and a fine trocar inserted.

FIG. 103.

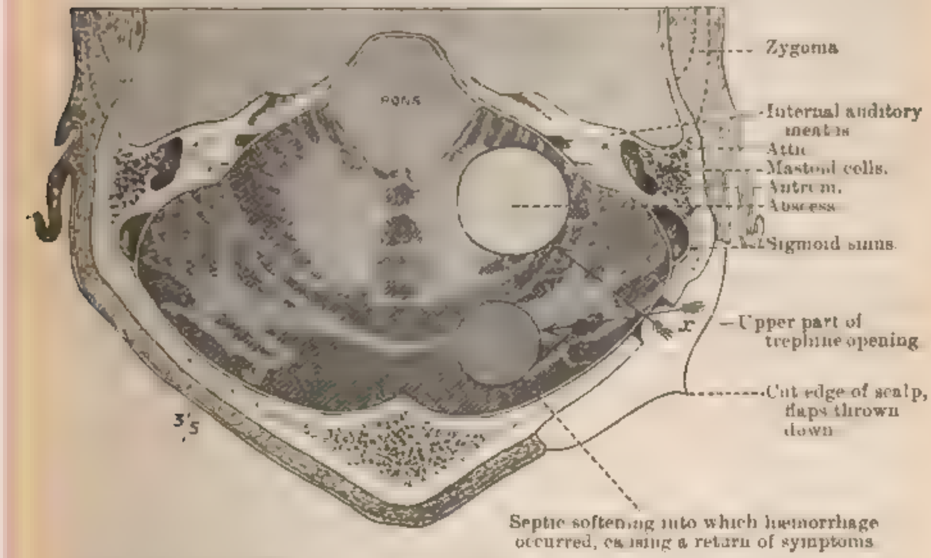


Mr. Dean's method of exposing the chief intracranial complications of chronic otitis media.

a, Line of skin incision. A semicircular flap commencing just behind the pinna, and having a diameter measuring about 2 inches. *b*, Pin of trephine placed 1¼ inch behind, and ½ inch above the centre of the external auditory meatus. *c*, Area of bone removed by bone-forceps, exposing the lateral sinus completely, and the dura mater above and below it, so as to admit of exploration both of the temporo-sphenoidal lobe and the cerebellum. *d*, Outline of the lateral sinus.

B. **Operation of Trephining for an Abscess in the Cerebellum.** Mr. Barker (Fig. 102) advises a point 1½ inch behind the centre of the meatus and 1 inch below the base-line. ("A line running from the lower border of the orbit backwards through the centre of the meatus." Reid.) This point is well behind the vertical, and well below the horizontal part of the lateral sinus, while it gives access to all the anterior third of the lateral lobe, in which the pus is usually found. Mr. Ballance (*St. Thomas's Hosp. Rep.*, *loc. supra cit.*) writes: "A cerebellar abscess arising from ear disease is usually in the anterior part of the lateral lobe, close to the bone disease (inner side of mastoid or posterior surface of petrous) which has caused the infection. Place the trephine so that its anterior border is just behind the posterior border of the mastoid process, and so that its upper border is below Reid's base-line. After the dura is opened the trocar or pus-seeker should be passed forwards, upwards, and inwards through the cerebellum in the direction of the posterior surface of the petrous bone. Thus an abscess situated in the anterior and outer part of the hemisphere will be evacuated. If the abscess is in the anterior and inner part of the lobe[*] the cannula will have to travel quite two inches inwards from the surface before pus is struck. It is probable that in many instances an abscess has not been opened, and the patient's life lost, because the surgeon has hesitated to plunge the cannula in far enough. In abscess of the flocculus, pus will have to be found still more deeply." The same writer points out that abscess in the cerebellum may be due to infection from a sloughing

FIG. 104


Zygoma
PONS
Internal auditory meatus
Attic
Mastoid cells.
Antrum.
Abscess
Sigmoid sinus.
x
Upper part of trephine opening
Cut edge of scalp, flaps thrown down
3/5
Septic softening into which hæmorrhage occurred, causing a return of symptoms

Dr. Acland and Mr. Ballance's case of cerebellar abscess, secondary to otitis media suppurativa, successfully dealt with by trephining. (*St. Thomas's Hosp. Rep.*, vol. xxiii p. 1.)

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[*] Another way of getting at cerebellar abscesses situated in the anterior part of the cerebellum, and due to infection by the labyrinth and internal auditory meatus, has been suggested, *i.e.*, along the posterior surface of the petrous bone. Dr. Green, Professor of Otology at Harvard University, publishes (*Amer. Journ. Med. Sci.*, April 1899) three cases of cerebellar abscess, in two of which an attempt was made to find the pus by this route. Neither was successful, though it is stated that the necropsy showed that both director and dressing-forceps "must have gone, without any question, directly into and through the seat of the abscess." Dr. Green draws useful attention to the fact that anterior cerebellar abscesses due to labyrinthine infection will always, from their situation, be more difficult to reach than those situated more posteriorly and due to mastoid (*e.g.*, sigmoid sinus) infection. For the former he still recommends the route *via* the posterior border of the petrous. But though this route is much shorter than that through the occipital bone, the opening by which the surgeon works is very small, not more than half an inch in diameter, and his route and his field for working are very cramped. Cerebellar abscesses are sometimes small and sometimes more than one in number. It has been abundantly proved that one cause of failure to find an abscess in the brain has been due to the surgeon not allowing himself sufficient room for exple

sigmoid sinus, and not from the disease of the temporal bone. When a second abscess forms, which is not uncommon in the cerebellum, it should be looked for on the inner side of the first or posterior to it. For further details in dealing with a cerebellar abscess the reader is referred to those already given at p. 252.

In three successful cases I had no difficulty whatever in finding the abscess, but it was by no means equally easy to feel sure that the drainage-tube was properly inserted and retained in the abscess cavity.

In one case of temporo-sphenoidal abscess, which ultimately made an excellent recovery, I was unable, thirty-six hours after the trephining (Feb. 20), to satisfy myself that the tube, though still *in situ*, reached the abscess. As there was a great tendency to blocking of the tube, owing to the thickness of the pus and the amount of brain detritus present, it was not stitched, so as to allow of daily removal and cleansing. All did well for a fortnight, save that the temperature tended to remain subnormal. Then headache returned, and on March 10 I inserted a scalpel along the track of the tube, giving vent to thick, green, sweet pus. A larger drainage-tube was inserted and stitched to the flap, which was partly cut away to facilitate drainage. There was the same tendency for the drainage-tube to get blocked, and a fresh collection again took place, with return of headache. On May 1, I again evacuated from three to four ounces of pus, operating now through a hernia cerebri the size of a walnut. This was clipped away with scissors. After this third operation the patient made an excellent recovery. The hernia cerebri was cured by the constant pressure of a leaden plate notched for the drainage-tube. This was kept in place by the unremitting attention of my dresser, Mr. Meadows-Turner.

In the second case, a cerebellar abscess also due to right-sided otitis media,* the pus was expelled under very high tension through the exploring cannula, and the abscess probably emptied at once. The cavity closed and the wound healed rapidly.

In the third, a case of a frontal abscess in a girl, secondary, after some months, to a fall upon the nose, the patient was, without my knowledge, discharged with a small and apparently trivial sinus. This became infected and the symptoms of abscess reappeared. The case was finally cured after re-opening the abscess and the use of decalcified bone tubes.

It cannot be too strongly laid down that until the wound is soundly healed the patient is not to be allowed out of bed, still less to leave the hospital, however trivial appear the wound which still has to heal. The use of the drainage-tube and the administration of only light diet will often be needed for two or three weeks, and if there is any delay or doubt about the final healing the patient should be kept quiet in bed for another two or three weeks.

THROMBOSIS OF SINUSES.—The following remarks refer to thrombosis of the lateral sinus. This is a grave lesion, from its tendency to cause general pyæmia and distant suppurations. When the mischief is limited to this sinus, as is usually the case in the earlier stages, much hope may be placed in operative interference. Prof. Horsley (*Clin. Soc. Trans.*, vol. xix. p. 290) first suggested ligature of the internal jugular in these cases, and Mr. Lane (*ibid.*, vol. xxii. p. 262) first adopted this step with success, with the objects of securing more thorough removal of the septic thrombus from the sinus, and to obviate the passage of septic material or antiseptic injections into the circulation. In the *Lancet* (vol. i. 1890, pp. 1057, 1114) is a most instructive paper by Mr.

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* This patient was admitted in a state of insensibility and moribund; no anæsthetic was used.

Ballance, who has operated in four cases, in two successfully. Where the mischief, in rarer cases, has extended from the lateral to the other sinuses, interference will be hopeless.[*]

Mr. Ballance (*loc. supra cit.*) believes that the following group of symptoms, when present together, are pathognomonic of septic thrombosis:—1. A history of purulent discharge from the ear for a period of more than a year. 2. The sudden onset of the illness, with headache, vomiting, rigor, and pain in the affected ear. 3. An oscillating temperature. 4. Vomitings, repeated day by day. 5. A second, third, or more rigors. 6. Local œdema and tenderness over the mastoid,[†] or in the course of the internal jugular.[‡] 7. Tenderness on deep pressure at the posterior border of the mastoid and below the external occipital protuberance. 8. Stiffness of the muscles of the back or side of the neck. 9. Optic neuritis.

The treatment of these cases must, in Mr. Ballance's words, "be twofold—viz., the free exposure and removal of the focus from which the pyæmic infection has occurred or is threatening; and, secondly, the establishment of a block in the highway along which the infecting agents are travelling from the local focus into the general circulation."[§]

This is carried out by first turning back an appropriate flap, freely opening and clearing out the mastoid cells,[‖] and then enlarging the opening backwards to the point in Fig. 102. The landmarks for that part of the sinus most often affected have been given at p. 235. "It is usually found a quarter of an inch, though it may be only one-twelfth of an inch, from the surface. It is thus much more superficial than the antrum. The anterior line of the sinus is situated from one-eighth to a quarter of an inch behind the base-line of the supra-meatal triangle" (Macewen). As soon as the groove for the sinus is opened, foul pus or gas may escape. The condition of the sinus is investigated, the question of plugging being cleared up by an exploring needle, which, when withdrawn, may smell foully though empty. If a thrombus is present, before the surgeon proceeds further he should tie the internal jugular vein, at the level of the hyoid bone, with two chromic gut ligatures, and divide the vein between them.[¶] If the vessel is thrombosed at this point the ligature should be placed lower down at a point beyond the clot; but the prognosis is here less favourable.* The bony outer wall of the lateral sinus having been thoroughly cut away, the sinus itself is opened with sharp scissors, and all offensive clot within reach cleared out by the sharp spoon, curette, or a syringe with a fine nozzle. If, after this is done, blood begins to flow from either end, it is *per se* a favourable sign, as it shows that the clotting does not extend far into the collateral vessels. There will be no difficulty in dealing with any hæmorrhage from the lateral sinus provided there be room for dealing with it by means of a sufficient opening in the skull. Firm plugging with strips of iodoform gauze wrung out of carbolic acid (1 in 20), and, over this, a dressing of aseptic wool and a knotted bandage, will arrest any hæmorrhage, however free; as occurred in one of my cases, this hæmorrhage may recur freely during the first few dressings, but without any ultimate untoward result. Constant irrigation with mercury-perchloride solution (1 in 4000) should be employed, and iodoform thoroughly used. In one of Mr. Ballance's cases, though the patient's condition was greatly improved by the operation, the evidence of pyæmia (blood-stained expectoration and swelling of some of the joints) persisted. Ten days after the first operation, as pus could be forced out of the opening in the sinus by pressure on the neck, an incision was made down to the vein at the lower border of the parotid gland. The vessel was opened and pus came out; the sinus and vein were then irrigated with perchloride solution, the stream passing in either direction and bringing away offensive clot. The man recovered.

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[*] Mr. Sheild (*Diseases of the Ear*, p. 176) gives an instructive case of this kind. Here the eyeballs protruded owing to the thrombosis of the cavernous sinuses. Prof. Macewen, in that storehouse of valuable information, *Pyogenic Diseases of Brain and Spinal Cord* (Figs. 53, 54, 55, pp. 248, 249), figures such a case.

[†] Absence of these points may be explained by sclerosing osteitis of the mastoid, and in rare instances, Mr. Ballance thinks, by absence of the occipital vein.

[‡] Œdema or tenderness over the internal jugular are due to extension of the clotting, and phlebitis, or to enlargement of the deep lymphatic glands.

[§] "Whenever the mastoid vein, which perforates 1¼ inch behind the meatus, and on a level with it, is found thrombosed, the sinus should be explored" (Pitt, *loc. supra cit.*).

[‖] The bone should be removed so as to give an opportunity of examining the dura mater over the temporo-sphenoidal lobe in the upper part of the wound, and thus dealing with any sub-dural abscess. Prof. Macewen points out the importance of cutting away the bridge of bone between the antrum and the sinus, as this bone "so frequently contains the channels through which the pathogenic organisms reach the sinus."

[¶] If in doubt the surgeon should tie the vein. It adds very little to the patient's risks. If, after ligature of the vein, pyæmic deposits take place, they may do so by means of the posterior condyloid or some unnamed vein.

The following directions for dealing with the sinus are given by Prof. Macewen (*loc. supra cit.*, p. 309):—"Frequently, in opening the sigmoid groove, granulation matter protrudes from the dura mater covering the sinus, and often along with this there is oozing of pus. If it be considered advisable to open the sigmoid sinus and turn out its disintegrating contents, then fully a vertical inch of the sinus ought to be exposed before opening it, in order to facilitate the operation and the measures necessary for its obliteration. Occasionally the wall of the sinus next to the bone is ulcerated, and, the sigmoid groove being opened, the contents of the sinus become exposed to view, when the disintegrating matter may be removed by the aid of a small spoon, or washed out—the former is the safer. Any space existing between the sigmoid groove and the sinus ought likewise to be cleared out and rendered aseptic. Granulation tissue protruding from the dura mater ought first to be carefully examined with the probe, lest it surround a sinus communicating with the cerebellum and leading into an abscess. If such a sinus exist it requires to be opened and the cerebellar abscess dealt with. If there be no sinus the granulation tissue ought to be removed, as it is apt to harbour infective matter in its sinuosities.

"To obliterate the lumen of the sinus its external walls, which were previously split, are folded inwards. A quantity of iodoform and boracic acid powder, sufficient to fill the interior of the cavity existing between the obliterated sinus and the bone, is introduced, care being taken in doing so not to exert so much pressure as to strip the sinus or surrounding dura from the skull. As in these cases an infective wound is being dealt with, the external portions of it are best stuffed with iodoform gauze, so as to permit free drainage, and healing by granulation tissue. By obliterating the sigmoid sinus over about an inch of its extent the influx of blood from the lateral and superior petrosal sinuses is arrested, and the efflux through the mastoid vein is likewise cut off."

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* In one of Mr. Ballance's cases, in which the vein was thrombosed, there was some difficulty in identifying it, as it was collapsed and appeared as a small round cord. In a case of Mr. Parkin's (*Lancet*, vol. i. 1893, p. 523) the vein was so thickened by periphlebitis as to resemble an empty carotid artery. The part excised showed numerous flaky deposits on the intima. The patient recovered, though there was evidence of advanced pyæmia.

EXTRA-DURAL ABSCESS.—This is considered with the following.

MENINGITIS.—This includes two chief forms, viz.: A. Localised pachymeningitis or sub-dural abscess; and, B. Diffuse suppurative lepto-meningitis.

They are thus described by Prof. Macewen in his masterly account of the various intracranial lesions with which the surgeon may have to deal in otitis media:—

"1. If the inflammatory process be slow, mild, and distinctly localised, involving a portion of the inner table of the skull, then an external pachymeningitis may form, possibly with pus between the dura mater and the bone, producing an extra-dural abscess. And again, when the dura mater has been exposed by osseous erosion, especially common about the tegmen tympani and the sigmoid sinus,* a mass of granulations is thrown out from the outer surface of the membrane. Such a mass is usually surrounded with pus, a portion of which is pent up intra-cranially, forming an extra-dural abscess, the contents of which ooze out if the neck of the granulation mass, as it issues through the erosion, be gently pressed aside.

"2. Should the above condition (of localised pachymeningitis) persist, adhesive inflammation is apt to spread to the inner side of the dura, which may result in a soldering of the inner membranes, the subjacent arachnoid and even the pia mater becoming adherent by the fibrinous meshes of the plastic exudation. Once this occurs, general lepto-meningitis is guarded against.

"3. After adhesive inflammation has brought about a localised soldering of the soft membranes to the dura, should an increase of the inflammatory action take place sufficient to induce a degenerative inflammation those membranes may soften, in the sub-dural space pus may form, which is prone to be followed by disintegration of the pia and superficial ulceration of the brain tissue. Two conditions may thus result. Should the pia mater remain intact, a sub-dural abscess may form; should the process extend to purulent softening of the pia and adjacent brain-tissue, then cerebral ulceration ensues, the disintegrating products being confined peripherally by the membranes, and by the brain on the inside. In either case the abscess is at first confined to, and enclosed laterally within, the area of the soldered membranes. Should the abscess enlarge considerably, and the disintegrating process affect the adherent membranes now forming the abscess-wall, it is possible that the disintegrating inflammation may spread laterally into the sub-dural space, or the abscess may burst into it, thereby setting up an acute lepto-meningitis.

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* And, especially in children, in the neighbourhood of the petroso-squamosal suture (Barker). Dr. Barr, of Glasgow, points out (*Brit. Med. Journ.*, vol. ii. 1898, p. 1234) that extra-dural suppuration in the sigmoid fossa—*i.e.*, on the outer wall of the sinus—may cause severe rigors and high temperature, though no evidence of sigmoid thrombosis exists, and that removing the extra-dural collection (together with any sepsis in the antrum, &c.) may bring about complete recovery without any need of opening the sinus or ligaturing the internal jugular vein.

"4. If the cause of the inflammation penetrate through the outer layer of the dura mater into the wide-meshed capillary network of its inner layer before soldering of the membranes has occurred, the whole dural space is open to invasion, and an acute far-reaching lepto-meningitis is apt to ensue."

In the final chapter of his book, Prof. Macewen states that he has had twelve cases of infective purulent lepto-meningitis, of which six were operated on and recovered. The majority were due to septic mischief reaching the membranes through the tegmen tympani; in a few the route was by way of the sigmoid sinus to the membranes in the cerebellar fossa. The lesson Prof. Macewen's success teaches is that the only way to deal with lepto-meningitis is by scrutinising any erosion in the neighbourhood of the tegmen or sigmoid sinus, to expose the inflamed dura freely here, and, after any extra-dural collection of pus has been dealt with, to freely incise the subjacent inflamed membranes, when purulent intra-dural exudation may escape, generally in drops, and continue to ooze for some time.

OPERATIVE INTERFERENCE IN THE CASE OF FOREIGN BODIES IN THE BRAIN.

Under the above heading such bodies as bullets, knife-points, &c., are included. Depressed and isolated fragments of bone may come within the meaning of foreign bodies, but have already been considered (p. 200).

A. *Bullets.**—The following questions will suggest themselves when a surgeon is called to a case of bullet wound of the skull:

1. *Has the bullet penetrated the skull at all?* Thus it may have lodged, rebounded, or fallen out, or

2. *It may have passed between the bone and the dura mater, without penetrating the latter, and reached a spot quite out of sight.* In such cases Sir T. Longmore advises the use of a curved probe, and extraction of the bullet "with suitable instruments," if it can be felt. Probably in most hands a second application of the trephine, if needful, at some distance from the wound, so as to extract the bullet there, would be preferable to attempts at removing it from the original wound.

3. *Has the ball split into two or more pieces?* Balls elongated as well as round are liable to split when impinging on sharp angles of bone. Thus, when the ball splits upon the outer table, part may pass beneath the scalp, while the rest may drive on before it some of the internal table, causing pressure on the dura mater, or even reach the brain.

4. *Has the bullet penetrated the brain?* If so, where does it lie? Ought any further exploration to be performed, and, if so, ought this

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* Mr. Barwell (*Clin. Soc. Trans.*, vol. xviii. p. 232) makes the following observation, which is of importance if it is found to be constant—viz., that, though the weapon may be held very close, there will be neither scorching nor powder-tattooing if the bullet be driven by one of the modern fulminates, contained in the same case with the projectile.

to be done through the original wound only, or at some counter-point as well?

Before attempting to answer these last questions, it may be well to deal with that which will be sure to arise first—viz., should the wound be explored, or treated expectantly?

The following appears to me to decide in favour of exploring in all cases in which it is clear that the injury is not going to be quickly fatal:

a. The fact that only by exploring will the surgeon be able to answer the question certain to be put to him by the friends, whether the brain is injured or no.

b. Whether the bullet has split, whether the internal table is shattered, and, if so, how far it resembles a punctured* fracture, are also points which can alone be cleared up by trephining.

c. Good drainage, disinfection of the wound, are almost hopeless unless this be opened up and explored by trephining if needful.

The following case is not only a good instance of the kind of gunshot injury to the head which may be met with in civil practice, but it shows how slight may be the injury which actually originates the fatal mischief. It was brought before the Clinical Society (*Trans.*, vol. xii. p. 5) by Mr. Lucas.

The patient, aged 21, had shot himself with a small revolver. "Almost in the centre of his forehead were two small circular holes, with slightly inverted edges. The surrounding skin was raised into a rounded eminence. There was some bleeding from the nose as well as from the wounds. On turning back flaps, a blackened cavity was opened beneath the skin, formed by the expansion of the powder after it had penetrated the integument. At the bottom of this cavity, a somewhat cruciform aperture was seen in the bone, and lying upon the internal table were two flattened bullets. The internal table was driven back so as to give the appearance of a sinus, in which the bullets were lying loose; and at the time we were under the impression that the man had very large frontal sinuses, which had been opened by the bullets. After removing numerous fragments belonging to the external table and diploë, the splintered internal table forming the posterior wall of the cavity was also removed. This came away in large, sharp-edged, angular fragments, two of which were grooved by the longitudinal sinus. When the internal table had been removed, the dura mater was seen at the bottom of the wound, and pulsating. The membrane was entire except at one spot, where there was a small aperture just such as might be made by stabbing the point of a penknife into a sheet of paper. But for that small puncture, it is not improbable that he would have recovered." Septic meningitis came on in about forty-eight hours, followed by death early on the sixth day.

The following points may be adduced for and against the attempt to remove bullets which have lodged in the brain:

The surgeon who decides to abide by the expectant treatment in these cases both immediately after the injury and later on, can justify his course by a sufficient number of cases. But it must always be remembered that many of these recoveries have been incomplete (*vide infra*), that in many the patients have had very narrow escapes, and that in others the case has been reported much too soon to be of real value.

On the other hand, no one, in my opinion, would blame the surgeon who, preferring exploratory to expectant treatment, endeavours to remove the bullet from the brain.

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* Excellent instances of how closely some gunshot fractures may resemble the classical "punctured" fractures, not only in the greater damage to the internal table co-existing with but slight mischief externally, but also in the onset of grave symptoms inevitably fatal [illegible] hining be performed early, are shown in Figs. 79 to 88, *Med. and Surg. Hi* [illegible] *the Rebell* [illegible] pp. 168, 169.

For while the cases of recovery after expectant treatment are few, it is probable that out of these, few as they are, a considerable proportion, if watched, would be found to be incomplete recoveries. Thus, Dr. Otis[*] writes of balls lodged within the cranial cavity:

> "Many instances were reported of patients who had survived the lodgment of missiles within the skull, but few or none resembling the cases reported by Larrey, of balls encysted in the brain and giving no inconvenience for years. It is, indeed, reported that some patients went to duty with balls lodged in the cerebrum; but the diagnostic details accompanying the history of these cases are not sufficiently precise to invite the fullest confidence. In most of the cases in which the evidence that the ball remained within the skull was conclusive, either fistulous sinuses existed, or there was much cerebral disorder,[†] or the position of the missile was discovered after the patient's death at a period remote from the injury."

The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later, even as long as thirteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain tissue, or yellow softening is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes. The usual termination is cerebral abscess, this condition having been found in fifty-three cases in which a post-mortem examination was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain symptoms, is that quoted by Wharton from Flourens. This observer found that bullets introduced into different portions of the upper parts of the hemispheres and the cerebellum gradually penetrated the brain substance, ultimately reaching the basis cranii, the bullet-tracks healing after them (Nancrede, from Wharton). "There is probably no authenticated case, of recent Anglo-American record, in which a bullet left in the brain substance has failed to work mischief, nor has the mischief been often long procrastinated. There have been occasional instances in which it has remained harmless for a number of years in the cranial cavity, but the brain has not been penetrated. The fact that epilepsy has developed so late as fifteen years after injury must make even apparently exceptional cases doubtful" (Phelps).

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[*] *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. p. 193.

[†] Prof. Nancrede (*Intern. Encycl. of Surg.*, vol. v. p. 72) gives the following inportant abstract of a most careful paper by Dr. Wharton (*Phil. Med. Times*, 1879) in which 316 cases of foreign bodies lodged in the brain are analysed. Of these, 160 recovered, while 156 proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in 106 cases, 72 recovering, while only 34 died. In the remaining 210 no attempt at removal was made, and only 88 recovered, 122 dying. A further analysis shows that, amongst those cases classed as recoveries, death ultimately took place in 10 at periods varying from three to ten years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deteriorated mental powers.

Gunshot injuries of the skull are so rarely met with in English surgery, their gravity is so great, and the question of their treatment arises so urgently, that it is hoped the following practical remarks may be useful to those who are suddenly called upon to take charge of such cases:—

Diagnosis and Treatment.—While the head is being shaved and preparations for an operation made, the surgeon will take note of any superficial lesions, such as marks of smoke or flame, grains of powder, and the original characters of the external wound, both for medico-legal purposes and for future guidance, all these lesions being soon liable to alteration. It is rare, supposing the patient to have recovered consciousness, that any localising symptoms are present, which can point to the lodgment of the bullet in a definite part of the cortex, *e.g.*, the motor area, the visual and speech area.* In a few cases, as soon as the whole head is shaved, the surgeon may gain evidence of the position of the bullet by finding on the opposite side of the skull a contusion of the scalp, an elevation of the bone, or only a tender spot, beneath which, after incision, some fine fissures may be detected (Phelps). The surgeon now explores the track of the bullet. As with the usual fine metal probes it is very easy to lose the track, make false passages, and thus inflict fresh damage, as well as add to the embarrassment and difficulty of the case, it will be wiser to make use of a sterilised straight bougie.† "It has been held that when the probe ceases to advance without the exercise of force, the limit of persistence has been reached. This is approximately rather than exactly true. The probe does not fall by its own weight into the depths of the cerebral wound. The channel which the bullet has left behind it is not likely to be open, but filled with coagula and disintegrated tissue, and some force, gentle as it may be, is required to penetrate this pulpy mass, and some manipulation alone can guide the instrument past obstructing osseous fragments or through an intracerebral dural opening" (Phelps). In those cases where owing to the shortness of range, or the large size of the bullet, the size of the wound in the skull and the destruction of tissue along the track of the bullet admit of it, the finger will replace any other means of exploring. Dr. Phelps gives the following as indications for the use of a needle when the bullet cannot be detected by a probe: "A resistance may be felt which the blunt instrument fails directly to reach; there may be reason to believe that the missile lies near the cerebral surface, while an angle in its track prevents direct pursuit without incision; a deeper wound may be too tortuous to follow; or localising symptoms may have developed."

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* Any such lesions, which may rarely be noted immediately, are due to the passage of the bullet; if occurring later on they will mark certain secondary morbid conditions. Of the infrequency of the aid which cerebral localisation gives, Dr. Phelps, of New York, thus writes (*Traumatic Injuries of the Brain and its Membranes*, p. 343): "The extent of cortical area, which, as yet, must be regarded as latent or of indeterminate function, is so great, and the further probability that the bullet will rest in some subcortical region is so strong, that such aid is scarcely to be expected." The above work is the outcome of large personal experience, and I here acknowledge my indebtedness to it.

† If, as is likely, the probe chosen is Nélaton's, the surgeon will remember two fallacies which may accompany its use: one, that the porcelain bulb may rub off a stain of lead from any structure on which the bullet has impinged, without actual contact with the latter; the other and more likely fallacy is, that the bullet may be so covered by blood or shreds of soft parts, or the porcelain so smeared with blood, that the characteristic stain may be wanting, though the bullet has been reached.

If the surgeon fail to find the bullet he will very likely wait for a trial of the Röntgen rays. If he succeed in finding it he must consider whether the state of the patient justifies further interference. But while profound unconsciousness and deepening coma or a marked condition of shock forbid any further interference, it will be better, if the site of the bullet can be traced with anything like certainty, to remove it at once, and so minimise as much as possible the risks of sepsis. Whether the bullet is to be reached directly or by counter-trephining must be decided by the depth at which it lies, according to the evidence given by the probe or by Röntgen rays.

Dr. Phelps thus advises on the justification of counter-trephining:—"The circumstances adverse to this step are—first, a bad general condition of the patient succeeding primary shock, a high temperature, a feeble and frequent pulse, and other indications of an inability to sustain the shock of further cerebral injury; second, extensive cerebral laceration about the wound of entrance, from the explosive effects of a large bullet at close range, or a suggestion of wide destruction in its track, from the severity and diversity of localising symptoms; third, great uncertainty as to the course of the ball, or its direction towards an inaccessible cranial area; fourth, the fact that its course has involved the base of the brain; and fifth, the bullet having been of 0·22 cal. or less. The fact that the bullet has taken its course upon or near the basilar surface is to be regarded as a contraindication, because it is more than likely to be deflected near the median line into a central region of the brain by resistance offered by some part of the ethmoid or sphenoid, or by the basilar process. The fact that the bullet is of 0·22 cal. or less is a contraindication, because its course is usually erratic and its track minute, and because its momentum is so comparatively slight that it rarely reaches an accessible part of the opposite cerebrum. No one of these contraindications, of course, is an absolute bar to operation. If, on the contrary, the constitutional condition is good and the laceration confined to a narrow track, if a bullet of 0·32 cal. or larger has been driven through the central or upper region of the brain towards some part of the vault, if its track can be traced deep into the opposite hemisphere,* and more especially if the patient have the advantage of youth, it will be judicious, after the exhaustion of other means, to resort to this ultimate mode of relief."

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* On the question of the probability of bullets in the brain following a direct track, Dr. Phelps writes as follows:—"If the wound can be traced directly inwards for an inch or more, while it is still possible that an elusive pistol-ball may have been deflected by a dural reflection, or have stopped short from exhausted force at any point just out of reach, it is more probable that it has gone straight onward at least as far as the opposite dural wall, and that further search must involve a new departure. It has been assumed that the bullet in its passage through the brain is likely to be diverted from its direct course by trivial obstacles, as is known to be the case in the extremities or in certain regions of the trunk. This complication is, in fact, less to be expected within the cranial cavity than elsewhere. The density of the brain substance is very much the same from one surface to the other, and it has been found in both ante-mortem and cadaveric wounds that the reflections of the dura mater are usually penetrated without the direction of the bullet having been changed. It is, nevertheless, the fact that in a considerable proportion of cases the bullet which fails of exit is turned aside from its

Before inflicting this additional injury, and running the risk of causing, perhaps, further severe loss of blood from incisions in scalp, dura mater, and brain, the surgeon will take into careful consideration the condition and vitality of his patient. The extraction of the bullet is best effected by slender forceps, or scoop.

It remains to allude to the question of disinfection and drainage. The external wound in the skull should be enlarged with Hoffmann's or other forceps (pp. 305, 308), thoroughly cleansed of any powder, dirt, or lead splashes by rubbing with sterilised gauze or by the use of the gouge. The incision in the dura should be sufficiently enlarged to give exit to any blood or cerebral débris. If uninjured or very slightly injured, the bullet having been deflected, the dura should be most carefully examined before it is taken for granted that the parts beneath have not been implicated. If this membrane, though uninjured, is bulging it is always to be opened. Any splinters of bone which have been carried along the track of the bullet are to be carefully removed. If irrigation of the bullet-track is practised, so as to get away septic clot or sloughs, it will be well to plug round the opening in the skull with strips of iodoform gauze lest the fluid carry septic particles into the arachnoid or sub-arachnoid spaces. Dr. Phelps is of opinion that drainage-tubes are to be employed with much reserve, and only in cases where there is great and widespread damage to the central regions of the brain. If used at all, drainage-tubes should be withdrawn and abandoned at a very early period, usually on the second day. If drainage is to be maintained for a longer time, horsehair or threads of chromicised gut may replace the tube, and their number be reduced from day to day. The following objections to the employment of drainage-tubes must be remembered: (1) that they are irritant foreign bodies; (2) that they are likely to become filled with clot, and thus act as plugs rather than as drains; (3) that they are media for the deep implantation of septic elements when the surface has become infected.

The following is an interesting instance of successful operation for the removal, by counter-trephining, of a bullet penetrating the brain:

The patient,* aged 19, shot himself with a pistol held very near to the centre of his forehead. About twelve hours afterwards, when seen by the surgeon, he was semi-conscious, aphasic, with complete loss of motion, without loss of sensation on the right side below the head. Left side hyperæsthetic. Pupils equally dilated. P. 100, T. 101·4°. Ether was given, and, under the protection of copious irrigations of corrosive sublimate solution (1 in 1000), the wound of entrance, nearly in the centre of the forehead, was enlarged, including also the wound in the skull. This procedure was complicated by most profuse hæmorrhage from a branch of the anterior cerebral artery, which was

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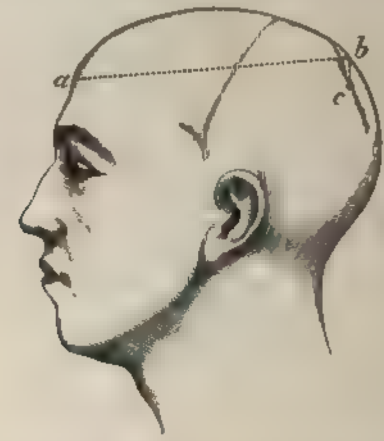
direct course. The change impressed upon its direction is due not to deep intra-cranial obstruction, but to the resistance offered by the cranial wall and dura mater at its entrance, or by the same structures upon which it may impinge at a point upon the opposite side of the head. A bullet, especially if of small size, with or without penetration of the dura mater, is often at once deflected at a right angle, or, if of larger size, after traversing the brain, and having insufficient force to penetrate the opposite dural wall, falls back into the track and is diverted, perhaps to a considerable distance, in some new direction."

* Th [illegible] 'as under the care of Dr. Fluhrer (*New York Med. Journ.*, March 28, 1885).

finally controlled by small compression-forceps left *in situ*. To this arterial bleeding was added a considerable venous flow from the superior longitudinal sinus, which, like the artery, had been cut across by the bullet. The track of the ball through the brain was then examined by a straight Nélaton's probe,* and the point on the scalp noted at which the probe would emerge if projected through the head. At this point the cranium was exposed and trephined. The trephine-hole was enlarged towards the assumed opening of emergence of the bullet, and the dura mater slit in the same direction. Some effused blood and disintegrated brain-matter appearing, more of the skull was cut away, and the slit in the dura mater prolonged until a gush of brain matter and a rent in the pia mater demonstrated the point of impact of the bullet. The probe was introduced through the opening in the pia, and passed downwards towards a point where a feeling of resistance had previously been noted with the tip of a finger introduced through the second opening. At the distance of an inch the bullet

FIG. 105



a, *b*, Track of bullet and site of the trephine openings. *c*, Spot where the bullet was found. (Fluhrer.)

was detected, and then extracted with slender-bladed forceps; it weighed 42 grains. One end of a small rubber drainage-tube was secured to one end of the probe, this was again passed through the brain from before backwards. The tube, as it was drawn through the wound, became filled with brain-detritus and blood. The after-history was one of gradual but progressive amendment. On the sixth day the drainage-tube was withdrawn, and replaced by a drain made of four strands of catgut and ten of horsehair, this being passed by tying it on to the anterior end of the drainage-tube. As the tube was withdrawn the drain occupied its place. It was removed, strand by strand, on different days. On the eighth day the compression forceps was found to be loose. A hernia cerebri developed at both cranial openings. The herniæ being subjected to a slight continuous pressure gradually disappeared. Eleven weeks after the operation both wounds had healed. The operation was completed in about four hours, the greater part of the time having been spent in stopping the cerebral hæmorrhage. After leaving the hospital the patient returned to work, a slight impairment of memory being the only apparent consequence of his wound. A severe blow accidentally made upon the anterior scar, some months after returning to work, determined a violent convulsive attack, which recurred at the end of three weeks. Bromides were freely given, and no further recurrence had taken place when the report was made six months later.

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* Dr. Fluhrer considers that a probe for these cases should supply the following conditions. The end should be large, so as not to wound the brain and make a false passage, and also, when beneath the surface, be easily discoverable by palpation or dissection. It must be sufficiently rigid to retain a given shape, and sufficiently bulky to supply a large surface to the fingers. Finally, it should be as light as possible that delicacy of touch be not lessened, and that no vibrations be lost instead of being communicated to the fingers. It should be made of tempered aluminium. If it be necessary to curve it near the exploring end (which increases the errors in interpreting the position of the extremity), the other end of the shaft should be bent, in the same plane, in the opposite direction.

The case will amply repay careful perusal. It is a splendid instance of what surgical skill and sagacity can effect.

Röntgen Rays.—This method has proved itself highly useful of late in the localisation of bullets within the skull. For the following remarks on its employment I am indebted to Mr. Edward W. H. Shenton, who is in charge of the Röntgen ray department at Guy's Hospital:—

"It is possible by means of the Röntgen rays to estimate the size of, and to exactly locate, bullets or other bodies which have become lodged in the cranial cavity. With a Crookes' tube of sufficient penetrative power—preferably the kind that gives the bone-image upon the screen as a soft grey shadow—the bullet may be seen *in situ* in the lateral position, and, under favourable circumstances, even in an antero-posterior. When a head is viewed in this latter direction, so much dense tissue has to be penetrated by the rays that it is a rare occurrence for a bullet to be shown upon the fluorescent screen. In determining the exact position of a foreign body in the head, it is obvious that greater accuracy is needed than in most other situations of the body. Many methods have been devised for the purpose of obtaining this exact localisation. The simplest method, perhaps, is that where two skiagrams are taken—one in an antero-posterior direction, the other in the lateral. These two pictures will, if taken with due care that the directions are as nearly as possible at right angles to one another, prove of assistance to the surgeon in an operation for the removal of the foreign body. A few details of the process for obtaining these two views will not be out of place here. The patient is placed on his back on a table with a canvas top, and the tube is arranged beneath his head and beneath the table. He should lie squarely upon his back, his head being steadied with sand-bags. The room being darkened and the tube illuminated, the screen is placed upon the patient's forehead. The tube is now moved about until the image of the head presents symmetrical outlines. A photographic plate is substituted for the screen, and the requisite exposure given. For the second skiagram a similar process is performed with the head in a lateral position, the patient's profile being the guide as to the accuracy of the directly side-to-side view. This method, though satisfactory as a rough guide, is far from perfect, there being so many directions in which error may be made. Another system, and a far more accurate one, is that now in common use at Guy's Hospital. It is a system whereby the exact distance from any given point may be found, and the principle upon which it is based is as follows:—When an image is being viewed upon the screen and the tube moved, the shadows of the various parts of the object viewed will move upon the screen at different rates according to their distances from the screen; that is, the nearer to the screen the less distance their shadows will travel in a given time. Quite superficial objects, those almost touching the screen, will hardly move at all. By a suitable arrangement of mechanism exact measurements are easily obtained, and, in all cases where the foreign body can be seen upon the screen, this can be accomplished without the involvement of any photographic process. If considered desirable in the case of bullets in the head, a skull may be taken and a bullet arranged in it, by the aid of the measurements obtained, to correspond in situation to the original bullet. Such a device will prove of great value to the surgeon at an operation for the removal of the foreign body. When exact localisation has been obtained, radiography can go no further, unless the practice of operating with the rays to hand is adopted. By such a method the surgeon is enabled to see the position of the foreign body from time to time, and any metal instrument he may be using. Until tubes of greater power are forthcoming this method cannot be advised for cases of bullet in the head."

A paper by Braatz* (*Centr. f. Chir.*, Hft. i. 1898) on the successful extraction of a bullet from the brain, with the help of the Röntgen rays, is of much practical interest. It will be seen that in this case a first attempt was unsuccessful, and that a needle was of much use in detecting the actual site of the bullet.

A lad, æt. 16, was in November 1895 shot in the right temple by a revolver-bullet of small size. The immediate symptoms passed away in a few days, but, after an interval of good health lasting for six months, intense headache was complained of in the left side. The Röntgen rays—a plate having been placed beyond the left side of the head—showed the foreign body lying in front of the left ear, and on the level of the zygoma. A little higher was another shadow which was thought to show that spot on the inner wall from which the bullet had rebounded. Braatz made an unsuccessful attempt to remove the bullet, the operation being hurried owing to the failure in respiration under the anæsthetic. After waiting for two weeks the headache returned as intensely as before. On Nov. 17th, 1897, the position of the bullet having been again defined by the Röntgen rays, the old wound in the skull and dura mater was opened up, and when the surface of the brain was exposed, a small hard body could be felt on exploring with a blunted needle. The brain tissue having been divided along the track of the needle, the bullet was easily extracted. A rapid recovery followed.

B. Other foreign bodies besides bullets which may penetrate the brain are *knife-points*. These, with their tendency to form cerebral abscess, have already been alluded to (p. 201).

C. Another class of body which may be met with by the surgeon in civil practice is shown in the following case of Mr. Couper's:†

A house-painter fell twelve feet from a ladder, impaling the right side of his skull on the spike of an iron palisade. When brought into the hospital there was a clean-cut wound three-quarters of an inch long, immediately under the right ear, partly overlapped by its lobule. In this the end of a large rough piece of metal, corresponding to a freshly broken spike, could be felt, and its direction could be inferred to be upwards, inwards, and a little forwards from the outer wound, which was situated half an inch under the external meatus between the mastoid process and the ramus of the jaw. There was some bleeding from the right ear, but no facial or other paralysis. The patient being under chloroform, Mr. Couper succeeded, after much forcible wrenching, in extracting the iron, the head being as far as possible steadied by three students and the operator's hand. During these efforts three or four ounces of blood oozed from the wound; this hæmorrhage ceased as soon as the iron was out, but a small quantity of semi-fluid brain substance flowed. Right facial paralysis came on two days after the injury, then delirium, restlessness, and on the seventh day left hemiplegia, followed by convulsive attacks affecting the right limbs and right half of the face. Two days later, or nine days after the accident, the patient died.

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* The following are other references on this subject: Scheier (*Deut. Med. Woch.*, May 7, 1896; Meyer, *ibid.*, Oct. 1, 1896; v. Bergmann, *Berl. Klin. Woch.*, 1898, Bd. xviii. S. 389.

† *Lond. Hosp. Reports*, vol. ii.; Hutchinson's *Clin. Surg.*, vol. i. p. 91, pl. xvii.

Necropsy.—No pus between the dura mater and the bone; dura mater healthy, save for congestion. On opening it, the surface of the right hemisphere showed well-marked sub-arachnoid meningitis. The posterior part of the right middle cerebral lobe had been deeply wounded: the brain substance, at this spot softened and streaked with pus, was healthy everywhere else. The spike had entered just under the apex of the mastoid process, traversed the internal ear, and driven several irregular masses of petrous bone through the dura mater.

Probably, in a similar case, the careful use of chisel or gouge would loosen the foreign body, while the opening up of the wound would facilitate drainage and cleansing the parts damaged, including the brain itself.

TREPHINING THE FRONTAL SINUSES.

This operation is required in cases of disease of the frontal sinuses and their mucous membrane resisting milder measures. Such disease may follow influenza, as in one of the cases mentioned below, or it may be due to some nasal source, *e.g.*, polypi or chronic hypertrophic rhinitis, leading to interference with the patency of the fronto-nasal passage. The cases fall into *two groups*—(*a*) *the obvious*, *i.e.*, those in which the local symptoms, whether of an acute or chronic nature, distension, inflammation, supra-orbital pain, tenderness on pressure, are clearly marked; and (*β*) *the latent*. Here the symptoms are mainly two—(1) headaches originating in the frontal region, and (2) muco-purulent discharge, constant or intermitting, from the nose. Dr. Tilley (*Lancet*, vol. ii. 1896, p. 866) points out that in these latent cases the source of trouble is often overlooked, and a correct diagnosis not made. He also notes that with disease of the frontal sinuses there may co-exist mischief in other of the accessory cavities of the nose, and that chronic suppuration in the antrum may closely resemble that in the corresponding frontal sinus.

At a recent discussion on Frontal Empyema at the Laryngological Society (*Journ.*, 1899, vol. xiv. p. 469), Mr. Symonds divided the cases into three groups:—(i.) Those in which there is purulent discharge from the nose, with, as a rule, formation of polypi. (ii.) Those in which there is distension of the sinus without nasal discharge. (iii.) Those in which there is distension of the sinus together with nasal discharge of pus. Attention was chiefly given to the diagnosis of the first class of cases, as the class most frequently coming before the rhinologist. He laid stress upon the fact that, whenever pus was seen amongst or around polypi, suppuration of one or more of the sinuses was indicated. He considered the pus to be the cause of the polypi, and to explain the frequent recurrence of polypi when the pus itself had not been traced to its origin. Where the polypi were numerous, it was impossible to say from which sinus the pus was coming, but he held that where they were very numerous, and there was much pus, with a foul odour, the maxillary antrum was certainly involved, with or without the frontal sinus. Where the frontal sinuses alone were involved, the polypi were less numerous, the granulations fewer, and the pus as a rule inodorous.

Operation.—The parts having been carefully cleansed, a single median vertical incision* is made down to the bone, about 1½ inch long, and terminating at the root of the nose. The periosteum having been carefully cleared back on either side, a trephine the size of a sixpence is applied in the middle line. When the bone is soft, a gouge and mallet—the latter being carefully used (p. 240)—will suffice.

If more room be required, a second incision is made along the line of the eyebrow, previously shaved, and an angular flap turned outwards. But a single median incision will allow of both sinuses being explored, and causes a very small scar.

When the trephine has been found to enter a cavity which the point of a quill or a probe shows to lie rather at the lower part of the crown, the disc is removed. If the sinuses are large, this is readily effected; but if they are small, the disc must be removed piecemeal, with a mallet and chisel, until the sinuses are laid bare. The bleeding is slight.

The object which now meets the eye is the livid mucous membrane lining the sinuses. On opening it, it is found thickened, and to contain mucus or muco-pus. This being sponged away, any polypi removed, and the orifice in the nose found with a sterilised probe or a fine gum-elastic catheter, a drainage-tube, about the size of a crow-quill, should be slid down into the nose, and its upper end, perforated, left in the sinus, the skin being united over it, to secure union by first intention.

If the opening be too small, or if it be occluded, it may be opened up by passing a pair of Lister's sinus-forceps from below through the nose, and driving them through at a spot where they are felt to come very close to a finger placed in the lower part of the opened-up sinus. The termination of the infundibulum or fronto-nasal passage in the middle meatus is about on a level with the palpebral fissure (Godlee, Quain's *Anatomy*, appendix, p. 3). If the attempt to open up the passage is made from above, it should be remembered that both the direction and depth of the infundibulum vary very much. In Dr. Tilley's words: "As a rule it is situated much further back than is usually supposed, and a large curve is necessary to pass a probe successfully down the fronto-nasal passage into the middle meatus of the nose."

In those cases where, owing to great thickening of the mucous membrane, foul caseous pus, &c., it is necessary to use the sharp spoon, and to disinfect the recesses of the sinuses by thorough syringing, the application of very finely powdered iodoform (sterilised by being kept in 1 in 20 carbolic acid, or 1 in 500 formalin solution) or brushing over with zinc-chloride or silver-nitrate solutions, it will be wiser to run the risk of more tedious closure of the opening, and to bring the upper end of the drainage-tube out on to the forehead, only partly closing the wound around. This will ensure more efficient washing out of the sinuses. As soon as it is safe the upper part of the tube is cut off, and the operation wound allowed to close. A fistula may persist here for some time. The tube must be worn in the nose for some weeks, that patency and drainage may be secured.

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* Some have recommended an incision in the line of the shaved eyebrow, as likely to leave a minimum of scar. Dr. Tilley points out (*loc. infra cit.*) that in cases where one or both sinuses are ill-developed this incision will open the cranial cavity. A median vertical incision is adapted to all cases.

In 1894 I had occasion to trephine the left frontal sinus in the following case:

The patient, a hospital nurse, had persistent frontal headache, with tenderness, after influenza. The left sinus having been exposed by the steps given above, the mucous membrane was found to be purplish in colour, much swollen, and bleeding freely. The communication between the sinuses and the nose, which appeared to be closed, having been opened up with sinus-forceps, to diminish the risk of scarring, I replaced the crown of bone, notching this for the exit of a small drainage-tube. I had reason to regret that I had not drained through the nose, as a sinus persisted, necessitating removal of the crown of bone, which had necrosed. A drainage-tube having been passed by the nose, the wound rapidly healed.

In 1898, I operated on an enormously distended right sinus, with typical egg-shell crackling of the vertical plate, and marked displacement of the eye downwards and outwards, in an old woman of 65. The distension here was so clearly situated on the right side that I made my incision along the line of the eyebrow, so as to lessen the deformity. The case was chiefly remarkable for the extremely inspissated and tenacious character of the fluids which distended the sinus, and the fact that the septum between the two sinuses was deficient over an area the size of a sixpence. A communication with the nose having been established, the case did well, though the age of the patient and the enormous distension of the sinus rendered the healing process slow.

It is possible that analogous operations would be found useful in very obstinate cases of ozæna in which there is evidence of the mischief having extended to the frontal sinuses, and in which, therefore, other treatment has been insufficient.

Every attention should be paid to keeping the wound aseptic, and to preventing erysipelas and intracranial complications. A sealed dressing may only be applied when it is certain that the deeper part of the wound is thoroughly healed. Occasionally graver sequelæ follow septic mischief in the frontal sinus. Owing to suppuration causing caries, or to osteo-myelitis, or from a natural aperture existing in the bony wall of one of the sinuses, a local or diffuse meningitis and abscess in the brain may follow. Dr. Gibson, of New York, records (*Amer. Journ. Med. Sci.*, March 1899, p. 305) a case which illustrates the last-mentioned condition:

A patient who had been twice operated on for empyema of the left frontal sinus, without any drainage by the nose being established, came under his care with a discharging sinus at the seat of the former operations. The opening having been enlarged, the sinuses were curetted, cleansed, and drained through the nose. Septic meningitis followed, and the patient died nine days later. The necropsy showed that the right frontal sinus communicated with the inner surface of the skull. The nature of the opening remains uncertain. Dr. Gibson points out that his case shows the necessity, in patients in whom both sinuses are affected, of emptying these by a median opening common to both, and not, by an opening placed laterally, draining one sinus through the other.

CHAPTER III.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS.

OPERATIONS ON THE BRAIN.

CEREBRAL LOCALISATION IN REFERENCE TO OPERATIONS (Figs. 106 to 111).

Motor Area.—The motor area, or that part of the cortex in which lesions cause paralysis on the opposite side of the body, lies beneath the anterior half of the parietal bone. It may be said to be in form a parallelogram, about an inch wide, with its centre traversed obliquely by the fissure of Rolando.

Speaking succinctly, but perhaps with sufficient accuracy for practical purposes, the centre of speech lies (on the left side) at the lower and anterior angle, or a little below and in front of the area. Paralysis or convulsions limited to one lower extremity need the trephine at the upper end of the opposite motor area, paralysis of the arm at the middle third, paralysis of the face at the lower third. Three applications of a trephine with chipping away of bone will expose it for thorough examination; if the paralysis is distinct and limited, one or two applications will probably suffice to find the lesion. Where lesions are combined (footnote, p. 278), points intermediate between the respective centres must be exposed.

The following aids in finding the fissure of Rolando will be useful. I shall give two or three, as it is well to check one by another. It will be seen that they are very simple, easily remembered, and that they do not involve the calculation of angles, or the need of cerebrographometers or goniometers.

i. The upper end of the fissure is found about ½ inch behind a point midway between the root of the nose and the external occipital protuberance; the lower end is about 1 inch behind the bifurcation of the Sylvian fissure. This bifurcation corresponds to a point 2 inches behind and ¼ inch above the level of the external angular process of the frontal bone.

ii. Mr. Godlee, in a most interesting case of trephining for cerebral tumour (p. 280), used the following simple method of exposing the fissure of Rolando in its middle third:

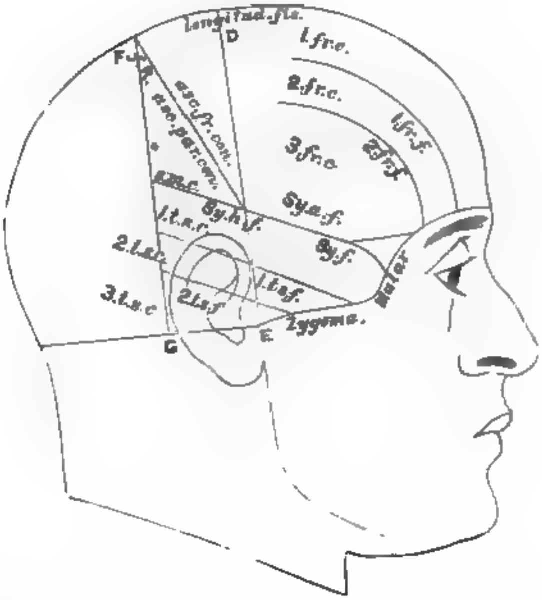
(1) A line was drawn between the glabella and occipital protuberances.

(2) At a right angle to this a line was drawn vertically downwards through the front of the external auditory meatus.

(3) Parallel to the last a line was drawn vertically upwards at the level of the posterior border of the mastoid process, reaching the longitudinal line (1) about 2 inches behind the second.

(4) From the junction of the lines 1 and 3, one was drawn diagonally downwards, reaching the second about 2 inches above the external auditory meatus. This was believed to represent the direction of the fissure of Rolando.

FIG. 106.



+ Most prominent part of the parietal eminence.* *f.R.*, Fissure of Rolando. *Sy.f.*, Sylvian fissure. *Sy.h.f.*, Horizontal line of Sylvian fissure. The ascending limb would start 2 inches behind and a little above the external angular process, running straight up for an inch between the letters *a* and *f* at *Sy.a.f.* 1 and 2 *fr.f.*, First and second frontal fissures. 1, 2, 3 *fr.c.*, First, second, and third frontal convolutions. 1 and 2 *t.s.f.*, First and second temporo-sphenoidal fissures. 1, 2, 3 *t.s.c.*, First, second, and third temporo-sphenoidal convolutions. (After Reid.)

iii. Method of Cathcart (*Trans. Edin. Med.-Chir. Soc.*, n.s. vol. xiii. p. 160).—Mr. Cathcart's habitual accuracy and reliability, together with the simplicity of his method, entitle this to be widely known. The method which he has worked out has only one measurement, and he believes it is sufficiently accurate, as he has verified the results upon Prof. Cunningham's models. The measurement which he takes is that required to find the upper end of the fissure of Rolando, which, according to Prof. Thane, was ½ inch behind the mid-point of a line extending from the glabella to the external occipital protuberance. The other points taken are the external angular process of the frontal bone, and the tubercle at the root of the zygomatic process. A line drawn from ½ inch behind the mid-point to the zygomatic tubercle gave the direction of the fissure of Rolando. A vertical line from the same tubercle struck the fissure of Sylvius at the point where its vertical branch began to show on the surface. Mr. Cathcart has found that starting 1½ inch behind the external angular process, the first part of the fissure of Sylvius ran upwards and backwards parallel to the lower border of the zygoma as far as the mastoid process. Behind that its position is very variable. The parallel fissure could be marked out parallel to the fissure of Sylvius and an inch below it. The lower part of the temporo-sphenoidal lobe runs parallel to the zygomatic arch. The fissures of the frontal lobe run at equal distances, a little in front of the fissure of Rolando. The position of the middle meningeal artery before it spreads out very nearly corresponds to the place where the vertical position of the fissure of Sylvius begins.

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* I think that this point is, in Fig. 106, placed too far back. Messrs. Anderson and Makins, in a paper on "Cranio-cerebral Topography" (*Journ. Anat. and Phys.*, vol. xxiii. p. 445), state that the parietal eminence is usually placed about midway in a line corresponding to E D, Fig. 106. While the parietal eminence is liable to vary, I should have thought that it was very rarely placed so far forwards as the above writers state. Prof. Turner (*loc. infra cit.*) considers that this eminence corresponds to the supramarginal convolution.

Fig. 107.

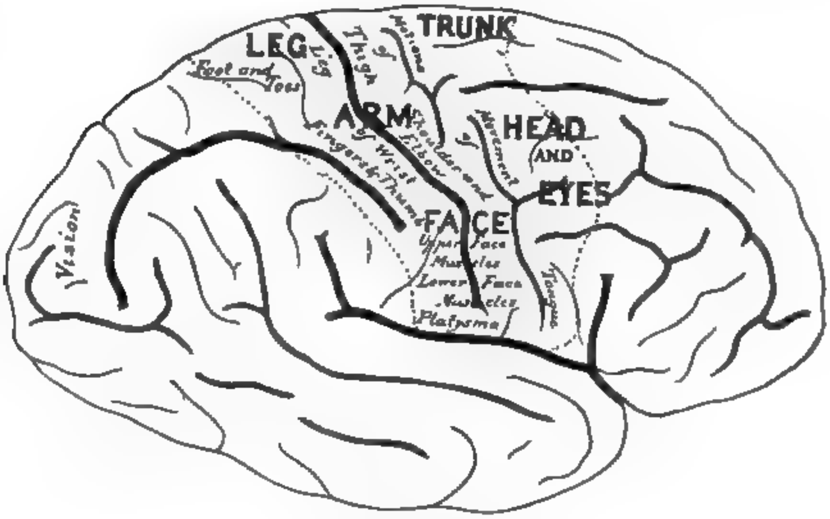


Diagram (after Eberstaller) of the fissures, convolutions, and the functional areas, with their extent on the right hemisphere of the brain. (Starr.)

The method devised by Mr. Anderson and Mr. Makins (Fig. 108) is somewhat similar to the foregoing.

(1) A line A B is drawn from the glabella to the external occipital protuberance.

(2) The half-way point C is joined to one D situated just in front of the ear on a level with the external auditory meatus.

(3) The lower third of this line C D is marked off at E, and

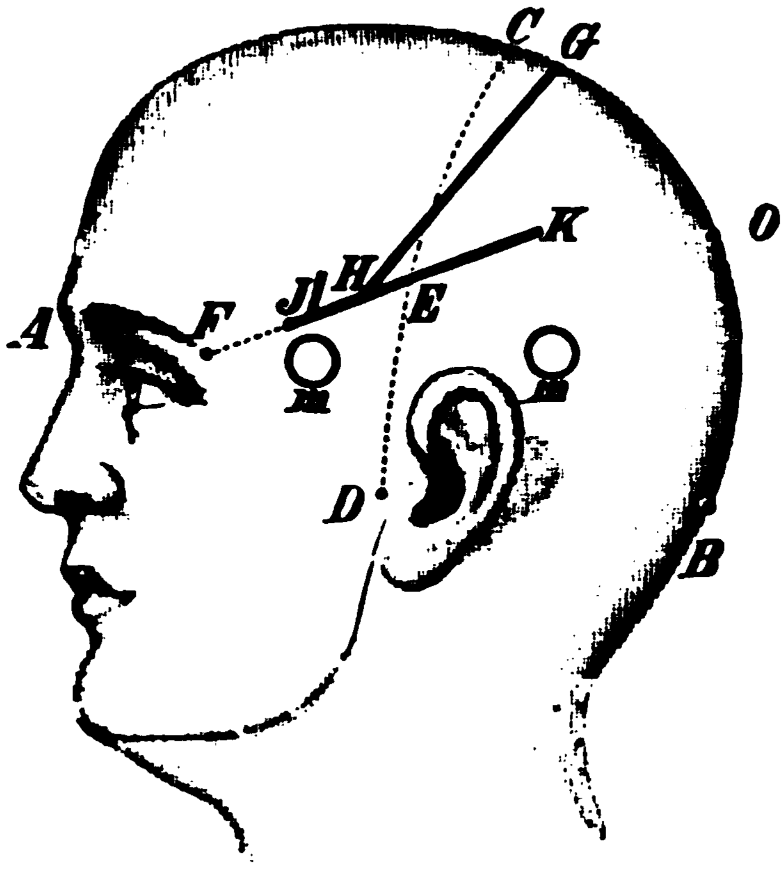
(4) A line F E is drawn to the most prominent part on the outer

border of the orbit at the outer end of the eyebrow. This gives the direction of the horizontal limb of the fissure of Sylvius.

The upper end of the fissure of Rolando is found at G, about a centimetre (⅖ of an inch) behind C, and runs from here in the direction G H,—H being on the line E F about 1 centimetre in front of E.

With regard to the directions already given and those to follow, it must be remembered that the eminences and sutures of the skull, and the relations of the sulci and convolutions beneath to the cranial surface, are liable to variations.* I believe that the points here given will be found easily defined, and occupying a central position with regard to the brain beneath and its possible variations. The surgeon must be prepared to use his trephine and other instruments freely.

FIG. 108.



The method used by Mr. Anderson and Mr. Makins to determine the fissure of Rolando, *G H*, and the fissure of Sylvius, *F K* and *J*. *m m* indicate the sites of trephining for the two divisions of the middle meningeal artery (p. 214). *F*, External angular process of the frontal bone. *K*, Termination of the Sylvian fissure. (Tillmanns.)

Position of the Chief Sutures (Figs. 109, 110).—After considering that most important part of the brain, the motor area, which lies under the parietal bone, it will be well to recall the landmarks of the chief sutures which are met with in that region. The *coronal suture*, the anterior limit of the parietal bone, may thus be traced. The point where it leaves the sagittal suture, the bregma, may be found by drawing a line from a point just in front of the external auditory meatus straight upwards on to the vertex; from this point the coronal suture runs downwards and forwards, speaking roughly, to the middle of the zygomatic arch, or, more exactly, to join the temporal part of the great wing of the sphenoid, which it meets 1½ inches above the zygoma, and not quite an inch behind the external angular process of the frontal bone.

Under this suture lie the posterior extremities of the three frontal convolutions (Fig. 110), for the frontal lobe lies not only under the frontal bone, but extends backwards under the anterior part of the parietal, the fissure of Rolando, which forms the posterior boundary of the frontal lobe, lying from 1¼ to 2 inches behind the coronal suture.

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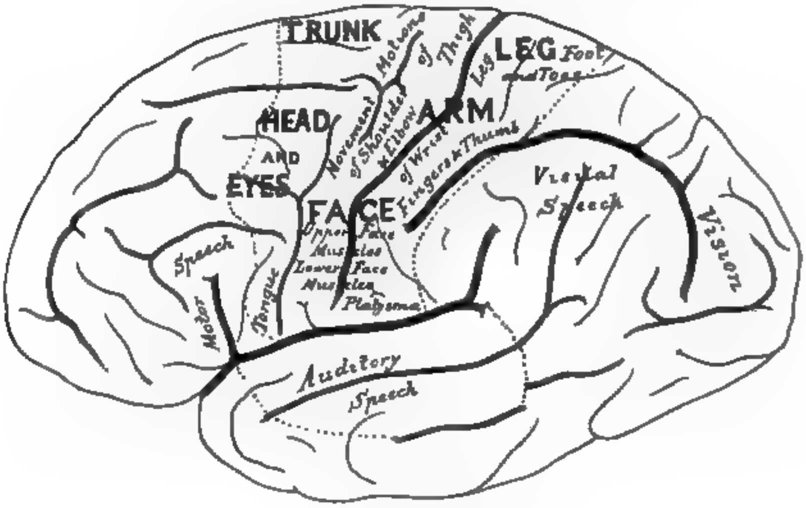
* See papers by Prof. Turner, *Journ. of Anat. and Phys.*, vol. xviii.; Mr. Hare, vol. viii.; and Messrs. Anderson and Makins, *loc. supra cit.*

The occipito-parietal or lambdoid suture, the posterior limit of the parietal bone, will be marked out by a line which starts from a point 2¾ inches above the external occipital protuberance, and runs forwards and downwards to its termination, which will be found on a level with the zygoma, 1¼ inch behind the meatus.

As the occipital lobe is not limited to the upper portion of the occipital bone, but extends forwards under cover of the posterior part of the parietal, the parieto-occipital fissure lies about ¾ inch in front of the apex of the lambdoid suture (Fig. 110). But this varies a good deal according to the ossification of the squamous part of the occipital.

Fig. 109.



A diagram, similar to that shown in Fig. 107, of the left hemisphere. (Starr.)

The squamous or squamoso-parietal suture is not so easy to mark out, owing to the irregularity of its curve and variations. Its highest point is usually 1¾ inch above the zygoma (Fig. 110).

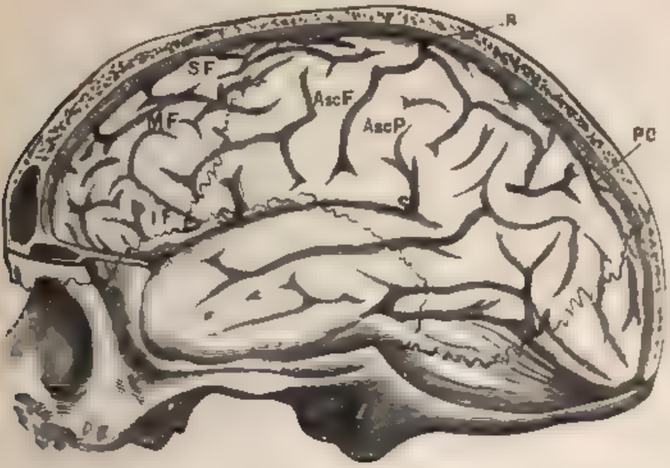
The Sylvian fissure, which separates the temporo-sphenoidal from the parietal lobe, passes from below obliquely upwards and backwards across the line of this suture near its middle (Fig. 110), the temporo-sphenoidal lobe not only lying under the squamous and great wing of the sphenoid, but passing upwards under cover of the lower part of the parietal. In Prof. Turner's words, this fissure commences immediately behind the posterior border of the lesser wing, and in its course backwards and upwards is covered by the great wing of the sphenoid, where it articulates with the anterior inferior angle of the parietal. It then passes obliquely under cover of the anterior superior part of the squamous bone, and appears in the lower part of the antero-parietal region. The fissure of Sylvius (Figs. 106, 110) is found by drawing a line from a point 1¼ inch behind the external angular process of the frontal bone to a point ¾ inch below the most prominent part of the parietal eminence. Measuring from before backwards, the first ¾ inch of this line will represent the main fissure, and the rest its horizontal limb. The ascending limb will start 2 inches behind and slightly above the external angular process, and run vertically upwards for about an inch.

The following practical points are given by Prof. Nancrede:

(1) Monoplegia or spasms limited to one member, or a portion of one member, indicate limited lesions. If the lower limb be affected, the upper portion of the ascending parietal convolution (Figs 106 to 111), with perhaps also the corresponding part of the ascending frontal, is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

(2) With paralysis of the arm and leg, the lesion probably involves the upper two-thirds of the ascending convolutions, with the paracentral lobule The trephine should then be placed at the upper part of the line, a little lower than in the former case. It may perhaps be necessary to enlarge the opening by cutting out a circle lower down.

Fig 110.



The above view of the brain *in situ* shows the relations of the surface convolutions to the regions of the skull R, Fissure of Rolando, separating the parietal from the frontal lobe PO, Parieto-occipital fissure between the parietal and occipital lobes. S, S, Fissure of Sylvius, separating the temporo-sphenoidal from the frontal and parietal lobes SF, MF, IF, The superior, middle, and inferior frontal convolutions. Asc F, Ascending frontal convolution Asc P, Ascending parietal convolution The outlines of the coronal, squamoso-parietal, and lambdoid sutures are also shown. (After Turner.)

(3) Paralysis of the upper extremity alone probably indicates injury to the middle third of the ascending frontal convolution, and the trephine should be applied a little in front of the middle third of the fissure of Rolando.

(4) Paralysis of the lower part of the face points to a lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal.

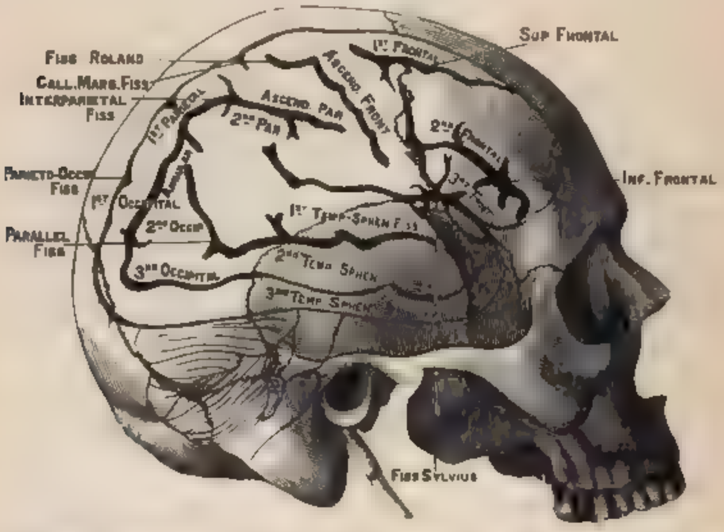
(5) In simple aphasia the trephine-crown should be placed lower

down still, in front of and below the lower extremity of the left fissure of Rolando.

(6) In most cases many centres are affected,* and consequently the surface to be exposed is much larger. Thus:

With paralysis of both lower extremities, the summit of the line and the contiguous superior portion of the cranium must be removed. With paralysis of one upper and one lower extremity (hemiplegia), the operation must be performed at the middle and upper portion of the line; in paralysis of the arm with facial palsy, at the inferior third of the line, and a little in front; in palsy of the upper extremity with aphasia, the opening should be made below and in front of the line; with facial paralysis and aphasia, the bone should be removed well in front of the left line, and below its inferior extremities (*Intern. Encycl. Surg.*, vol. v. p. 90).

FIG. 111


SUP FRONTAL
FISS ROLAND
CALL. MARG. FISS
INTERPARIETAL FISS
1ST FRONTAL
ASCEND. FRONT
ASCEND. PAR
2ND PAR
1ST PARIETAL
2ND FRONTAL
3RD FRONT
INF. FRONTAL
PARIETO-OCCIP FISS
1ST OCCIPITAL
2ND OCCIP
PARALLEL FISS
1ST TEMP-SPHEN FISS
2ND TEMP SPHEN
3RD OCCIPITAL
3RD TEMP SPHEN
FISS SYLVIUS

The chief convolutions and fissures on the outer surface of the brain, together with the outlines of the sutures and bones beneath which they lie. Diagrammatic (After Roberts, of Philadelphia.)

The above statements from Prof. Nancrede, following M. Lucas-Championnière, are liable to revision with advancing knowledge.

PRACTICAL VALUE OF CEREBRAL LOCALISATION.

I propose to give instances of this under the following headings:—(A) In head injuries; (B) In brain growths.

(A) **Cerebral Localisation in the Diagnosis and Treatment of Injuries to the Head.**—A typical case, in which localisation may help the surgeon in trephining, would be one in which the injury is limited to the cranium, and is followed immediately by paralysis. Secondary or tardy paralysis may be the result of later inflammatory processes.

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* The following combinations are those usually met with (Nancrede, *loc. supra cit.*, p. 89): Paralysis of face and aphasia; aphasia and paralysis of the arm; paralysis of *the arm and face*; paralysis of the upper and lower extremities.

M. Lucas-Championnière (*La Trépanation guidée par les Localisations cérébrales*, p. 107) gives this interesting case:

A man was found in the street with slight paralysis of the right arm, but sensibility perfect. There was a small superficial cut, ½ inch long, over the left parietal eminence. Five or six days later the patient became stupid and unable to swallow, and convulsions,* increasing in violence, and involving all the body, save the right forearm and hand, set in. Suspecting a fracture of the inner table, M. Lucas-Championnière trephined at the site of the wound, and found a fine fissure just in front of this; there was a slight depression of the fragments, which were wedged tightly together. After the operation the convulsions ceased, and a good recovery took place, with use of the right arm. The fracture was proved by measurements to be over the middle and lower part of the fissure of Rolando, considerably in front of the scalp wound.

The following case of cerebral lesion (Intracranial Sub-dural Effusion of Blood), diagnosed from motor symptoms alone, was given by Prof. Macewen in his most striking address at the Glasgow meeting of the British Medical Association (*Brit. Med. Journ.*, Aug. 11, 1888):

A boy had, consecutive to a fall six days before, convulsions beginning in the left side of the face, gradually involving the left arm and subsequently the left leg, consciousness being preserved. Paresis of these parts remained, though sensation was unimpaired. The parts were always affected in the same general order, and the convulsions, persisting, finally became general, with loss of consciousness. These motor phenomena indicated a lesion on the right side of the brain, pronounced at the middle and lower part of the ascending convolutions, as the face and arm centres were the first to show evidence of stimulation. The lesion was evidently of an irritative kind, such as might be caused by a bone spicule driven into the brain, or by pressure on its surface. It was clearly not destructive, *e.g.*, a severe cerebral contusion. It was resolved to expose the lower part of the fissure of Rolando. The head being shaved, a scarcely perceptible irregularity was detected near the coronal suture. Trephining was performed at a point slightly behind the auriculo-bregmatic line, and midway between the auditory meatus and the vertex. This happened to correspond to the posterior extremity of a fissure which ran across the coronal suture. There was no extra-meningeal hæmorrhage, but the dura was very dark. On opening this, 2 ounces of clotted blood escaped from the sub-dural cavity. There was no recurrence of the fits, and the patient survives in perfect health.

Case of Traumatic Aphasia successfully treated by removing Blood-clot from the interior of the Cerebrum†—

The patient had been struck on the head with a penknife six days before admission. At that time he had difficulty in speaking correctly, which had increased somewhat, and pain in the left side of the head, but no paralysis or loss of sensation. A small scar was found over the left squamous bone, 2 inches from the external angle of the orbit, and ¾ inch above the zygoma. Both forms of aphasia (motor, speaking; and sensory, word-blindness) were, to a certain extent, present. Five days later the scar was explored, and a wound of the squamous bone, in size and shape likely to have been produced by a small penknife, found, and cut out in a trephine-circle. The knife had penetrated the dura and brain, the large posterior branch of the middle meningeal just escaping. The dura being opened, a sinus-forceps was gently passed along the brain wound, and, on separating the blades, a blood-clot presented, and was gradually extruded by brain-pressure. Some more was removed by the forceps and by a stream of weak mercury perchloride solution. A drainage-tube was inserted. On the evening of the same day the aphasia was much improved. Next morning the patient was again more aphasic, and it was found that the tube had become blocked. On freeing it, much fluid with broken-down clot escaped and the power of speech improved. The patient recovered uninterruptedly, regaining completely his power of writing, reading, and speaking. Dr. Ball believed that the knife had penetrated the superior temporo-sphenoidal gyrus, traversed the Sylvian fissure, and probably injured Broca's convolution.

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* Convulsions in themselves are only an indication for interference when they are localised and persist, and especially if they alternate with paralysis of the same muscles.

† Dr. C. B. Ball, *Trans. Roy. Acad. of Med. Ireland*, vol. vi. p. 155.

(B) **Cerebral Localisation in the Diagnosis and Removal of Cerebral Tumours.**—Amongst the cases which have been published there have been very few to surpass in helpfulness, from the completeness of the details and the accuracy of its reasoning, one of the earliest of the cases submitted to modern surgery—viz., that trephined by Mr Godlee for Dr. Hughes Bennett in 1884 (*Med.-Chir. Trans.*, vol. lxviii. p. 244), an abstract of which is given below:

A man, aged 25, had, four years before, suffered from slight concussion from a blow on the left side of the head. A year later, there first set in twitchings in the left side of the mouth and tongue, paroxysmal and irregular in occurrence. Some months after, fits began, with loss of consciousness and general convulsions. This condition lasted two and a half years; and six months before admission, twitchings of the left hand, followed shortly by weakness of the left fingers, hand, and forearm, were noticed. For three months these had prevented his using his tools. During this last period there had been twitchings of the left leg, which had also been getting weak. There was nothing abnormal in the skull or scalp. Vision was normal, but optic neuritis was present on both sides, most marked on the right. Hearing was less acute in the right ear. There was now complete paralysis of the left fingers, thumb, and hand, the elbow movements were very limited, those of the shoulder impaired. There was no rigidity or wasting of muscles. The toes of the left leg did not clear the ground in walking. There was persistent vomiting and retching, with attacks of lancinating headache, rendering life intolerable. Large doses of the iodides were fruitless.

An operation being decided on, the motor area and the diagonal line representing the fissure of Rolando were mapped out by the proceedings already given at p. 272. Theoretically, in order to hit the middle of the fissure of Rolando, the centre of the trephine should have been placed about ½ inch behind the diagonal line, and about 1½ inch from the median longitudinal line. As, however, there was a tender spot on the scalp 2 inches anterior to this, the first opening was made (with a trephine 1 inch in diameter) between the two.* The dura mater was normal; after a crucial incision was made in it, the brain was thought to bulge abnormally, and to be rather more yellow than usual, otherwise it was healthy. A second crown was cut away, overlapping the first, external to and slightly in front of it, and the angles of bone rounded off with a chisel and hammer, the brain being protected with a copper spatula. These two openings were then joined by one posterior to them, and, the edges being chipped away, a triangular aperture was left measuring 2 by 1¼ inches. The dura mater was opened, and a surface of brain exposed nearly equal in size to that of the skull-opening. Occupying most of this space, and crossing it obliquely from above and behind, downwards and forwards, was a convolution. Into the centre of this convolution an incision about ¾ inch in length was made with a scalpel. From ⅛ to ¼ inch below the surface lay a transparent, lobulated, solid tumour, thinly encapsuled, but quite isolated from the surrounding brain substance. The incision into the cortex being prolonged, the sides of the growth were easily separated by a spatula of steel, readily bent into any shape.

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* The centre of the opening was 1½ inch from the middle line and ¼ inch behind a line drawn vertically upwards from the meatus of the ear.

The superficial surface of the growth being thus isolated, this portion was removed with the finger; as part now broke away, the deeper portion was enucleated with a sharp spoon, the scraping being continued till apparently only healthy brain matter remained. This caused rapid welling-up of blood into the cavity, which would have held a pigeon's egg. Sponge-pressure failing, the hæmorrhage was finally arrested with the electro-cautery. The dura mater was drawn together with sutures, and a drainage-tube inserted beneath it. Elsewhere the skin was brought accurately together. Antiseptic precautions, including the spray, were used throughout. The anæsthetic, chloroform, was taken well.

The wound was not dressed till the third day, when the discharge had a distinctly putrefactive smell: the scalp near the wound was somewhat œdematous. The next day wet boracic acid dressings were applied. There was hardly any trace of smell, but a hernia cerebri as large as half an orange was protruding through the lips of the wound. There were no twitchings of limbs or face, no headache. The patient was bright and cheerful, with a good appetite. The hernia cerebri, however, increased, and on the eighth day, having reached the size of half a cricket-ball, was snipped away with scissors, the parts removed consisting chiefly of granular matter and clot, with, apparently, little true cerebral structure. The cut surface was treated with a strong solution of zinc chloride and iodoform, and a cap of block-tin applied. The hernia cerebri again increased somewhat, but all seemed to be doing well, when, on the twenty-first day, a rigor appeared, headache followed and vomiting, then restlessness, sleeplessness, and gradual sinking about four weeks after the operation.

At the autopsy extensive arachnitis was found. The parietal area appeared to have fallen in; in its centre, and occupying the position of the fissure of Rolando, was the wound in the brain. The destruction of the cerebral cortex involved nearly all the ascending parietal convolution, the upper part of the ascending frontal, and the anterior third of the supra-marginal gyrus. The extent of softening was not great, but it was difficult to tell this accurately, as the brain had undergone the process of hardening. The growth was a glioma, of the size of a walnut.

In the comments on the case, most interesting remarks are grouped under the following heads: (1) Diagnosis. (2) Surgical treatment. (3) Clinical phenomena after the operation. (4) Revelations of the necropsy physiologically and pathologically considered.

These will well repay most careful perusal; only the chief points can be given here.

(1) *Diagnosis.*—A brain growth on the right side was diagnosed in this case on the following grounds:—Slow progress, uncontrollable vomiting. Violent pains. Double optic neuritis. It was thought to occupy the cortex because certain motor tracts were implicated in definite order, because paralysis was present without loss of sensibility, and above all because of certain paroxysmal seizures of local convulsions occurring without loss of consciousness, eminently suggestive of irritation of the grey matter.

In this case there was complete paralysis of the fingers and hand, with inability to pronate and supinate the forearm, there was partial paresis of the movements of the elbow, and weakness of those of the shoulder-joint. There was also slight paresis of the leg and one side of the face. Accompanying all these there were paroxysmal convulsions in all these regions, occurring either singly or in definite order one after the other. These phenomena were to be accounted for by an extensive but not absolutely complete destruction of the motor centres of the fingers, hand, and forearm, with slight encroachment on and irritation of those of the face, upper arm, and leg. A very definite localisation was thus permitted, and the tumour was pronounced to have occupied the whole thickness of the middle two-fourths of the ascending parietal convolution, and a portion of the adjoining upper half of the ascending frontal convolution.

The growth was proved to be limited by the fact that the centres of the leg above, of the face and tongue below, of sight behind, and of the movement of the eyeballs in front, were not seriously involved. It could not have exceeded 2 inches in diameter, and proved to be a glioma, of about the size of a walnut, lying obliquely in the fissure of Rolando. As to the probable nature of the tumour, the age of the patient, the absence of syphilis, and the slow progress, suggested glioma.

(2) *The Operation.*—In this the advantages of the chisel and hammer over Hey's saw were exemplified. Mr. Godlee considered that the use of a larger trephine might be advisable in similar cases. One convolution only being exposed during the operation, there was at the time some question as to whether it was the ascending frontal or parietal. This doubt arose from the circumstance that in the attempt to approach the tender spot the theoretical position had been slightly departed from. After death, however, it was apparent that the convolution which had been incised was that in which from the first the disease had been diagnosed to exist—viz., the ascending parietal. There was no external appearance of disease about this part except that it seemed swollen, less glossy, and less vascular than natural. An incision into this showed the morbid growth to be immediately under the surface, and almost completely involving the entire thickness of the cortex. In clearing away the superficial parts of the growth a small spatula, neither sharp nor blunt, and so tempered that it would keep any shape given to it, was found most serviceable. It may be questioned whether it was advisable to arrest the hæmorrhage from the interior of the wound by means of the galvano-cautery, as the bleeding was not severe and would no doubt have become arrested by natural means. The use of this instrument appears to have brought about the putrefaction which was the cause of the inflammation and consequent hernia cerebri. It may be doubted if the putrefaction was ever completely subdued; the fact of the meningitis occurring at last, and that of smell having again become apparent after the attempt at removal of the second protrusion, point probably to a continued septic infection. As to the hernia cerebri, it was remarkable in the first place that the discharge continued for so long to be so copious and so watery as to suggest the idea of its being cerebro-spinal fluid.* Secondly, there was a difficulty in shaving it off owing to the enormous size of its base and the danger of serious hæmorrhage.

(3) *Clinical Phenomena following the Operation.*—The patient lost his headache, vomitings, and violent twitchings in the limbs; even the double optic neuritis markedly diminished. The only change which followed the operation was completion of the paresis of the upper extremity, evidently due to the unavoidable destruction of the remaining arm-centres in the removal of the tumour. Coincident also with the formation of the hernia cerebri came fresh symptoms, in the shape of paresis of the

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* Whether the lateral ventricle had been opened into, the post-mortem examination did not prove conclusively. There was no collection of foreign matter in its interior; at the same time the softening had extended close to it.

left leg and partial anæsthesia of one-half of the body. These were probably due to the effects of simple pressure, and possibly to the subsequent secondary softening of the conducting fibres caused by it.

(4) *Revelations of the Necropsy.*—The brain was, practically, everywhere healthy except over the area injured by the operation and in the membranes in the immediate neighbourhood. The meningitis was due to irritating matter from the interior of the wound flowing downwards between the layers of the arachnoid, and accumulating at the base of the brain. The local inflammation of the wound had opened out the parts, and separated the adhesions so as to allow the discharge to percolate into the cranial cavity, but not till three weeks after the operation.

The following "Case of Subcortical Cerebral Tumour treated by Operation," by Dr. Beevor and Mr. Ballance (*Brit. Med. Journ.*, 1895, vol. i. p. 5), should be studied in the original. As would be expected from the authors' reputations, it is most helpful from its scientific accuracy and fulness of detail:

(1) A woman, æt. 39, had, twelve months before admission, been gradually attacked by paralysis, involving successively the right ankle, the knee and hip; it extended after the lapse of seven months, to the right hand, and then to the whole of the upper extremity. (2) The classical symptoms of intracranial pressure, headache, vomiting, and optic neuritis were present. (3) The mental condition gradually deteriorated. (4) There was some loss of sensation, affecting the right limbs chiefly, while the face entirely escaped. (5) There was no history of tubercle or syphilis. (6) Under anti-syphilitic remedies, taken for over six weeks, the patient's condition grew worse. The progressive nature of the hemiplegia, together with the classical symptoms of intracranial pressure, optic neuritis, headache, and vomiting, made the diagnosis of a tumour almost certain. In settling its exact position, whether in the cortex, the centrum ovale, or the internal capsule, the following symptoms of lesions in these different parts were considered: "(*a*) The type symptoms of involvement of the cortex are: 1. Jacksonian epilepsy, the aura or the initial movement being represented in the part of the cortex first involved in the tumour. This is followed later by a permanent paralysis of the same part, which progresses in a definite order. 2. Corresponding to the paralysis of the limb segments there is change of sensibility. Light touches may not be felt, but if they are, they are not properly localised. Loss of muscular sense, so that the patient is not cognisant of the position or the passive movements of his limb. 3. Occasional tenderness of the skull over the site of the tumour. (*b*) The type symptoms of involvement of the internal capsule are: (1) Absence of Jacksonian fits. (2) The paralysis is progressive, but extends more rapidly than a cortical paralysis, owing to the closer gathering of the fibres. (3) Sensation tends to affect the whole of the opposite half of the body, including the head, to be more complete than in cortical lesions, and to involve all forms of sensation. (*c*) The type symptoms of involvement of the centrum ovale can only be determined by a process of exclusion, and they probably are modified according as the growth extends towards the cortex or towards the internal capsule. (1) Absence of fits. (2) Absence of tenderness of cranium. (3) Progressive paralysis and progressive loss of sensation, either of cortical or capsular type. In comparing the present case with the symptoms of the above types, the internal capsule appeared not to be involved in the tumour on account of the fact that the anæsthesia corresponded to the paralysed parts, and was not complete; further, localisation was imperfect, and muscular sense was lost, the face escaping completely. The gradual march of the paralysis, too, pointed away from the internal capsule. The diagnosis therefore rested between a cortical and subcortical lesion. It is first to be noted that the patient had never had a fit, and although it is known that a cortical tumour may be present for many months without giving rise to a fit, still the general rule holds good that the absence of fits is against the diag[illegible]tical lesion. Secondly, there was never at any time any tenderness of [illegible] which. [illegible]ent, makes for the diagnosis of a superficial cortica

lesion involving the dura. Thirdly, the sensation was of cortical type, and did not assist in the differentiation of a cortical from a subcortical growth, but it pointed to the lesion being nearer to the cortex than to the internal capsule. Fourthly, the sequence in which the different parts of the brain were involved, as shown by the march of the paralysis, was also instructive." I must refer my readers to the original for further minute details by Dr. Beevor. I have found space for those already given because of the importance of settling, from an operative point of view, whether a growth is cortical, subcortical, or in the internal capsule. The conclusion having been arrived at that the growth was subcortical and did not involve the internal capsule, the following operation was performed by Mr. Ballance, July 11th, 1894. The scalp having been prepared in the usual way, chloroform was given, and a large Horsley's ∩-shaped flap was thrown down on the left side. This flap included the periosteum, and allowed of the exposure of the coronal and sagittal sutures, about one inch of the posterior part of the frontal bone, and practically the whole of the parietal bone, with the exception of the anterior inferior angle, and the part immediately adjacent to the lambdoid suture. The portion of bone to be removed was then marked out by means of a large saw. It was in shape a parallelogram, whose anterior and posterior borders, running parallel with each other, were planned also to run parallel with the sulcus of Rolando. The anterior border encroached a little on the frontal bone at its lower end. The upper border of the parallelogram corresponded with the sagittal suture, and extended along it from the bregma for fully three and a half inches. The lower border was parallel with the upper and two and a half inches below it. The portion of bone removed would thus include the parietal eminence, and would allow of the free exposure of the upper part of the motor cortex, especially of the toe and ankle centres at the upper extremity of the ascending parietal convolution, which it was desired to thoroughly examine. The removal of the bone thus marked out was accomplished by the aid of the same large saw, by means of which it was divided up into small quadrangular pieces by vertical and horizontal cuts. These pieces were then easily raised from the dura by an elevator. As soon as one piece had been removed, the use of strong bone-cutting forceps facilitated the final separation of the pieces into which the bone had been mapped out by the saw. Along the upper boundary of the opening the final removal of bone was accomplished in part by disarticulation at the sagittal suture. The dura was exposed without injury, and the middle meningeal artery lay upon it without having been wounded. The dura bulged considerably into the opening. As it was clearly desirable to perform the operation in two stages, the edges of the scalp wound were now brought together by horsehair sutures, and the dressings applied. Six days after the first operation, the patient having completely recovered from its effects, chloroform was again administered. The wound was found united by first intention, but its edges were easily separated by the handle of a knife after the sutures had been cut. The flap was again thrown down, no bleeding occurring, and wrapped up in an antiseptic dressing. A little clot was lying on the dura. As large a square dural flap was next cut and folded down over the scalp flap. The cortex thus exposed was bulging, and, especially over the upper part of the ascending parietal convolution, presented a mottled and unnatural appearance. This mottling may have been due to minute ecchymoses produced during the removal of the bone a week before, or to malignant invasion of the cortex. The former alternative appeared the more probable. On palpation, no area of special resistance indicating the site of the tumour could be discovered, but on exploring the mottled ascending parietal convolution with the finger, the cortex, being here greatly thinned, was broken through, and the tumour, of a whitish-grey colour, was seen. As the ruptured cortex receded, the tumour appeared to be discontinuous with the brain substance, and an attempt with the finger and the handle of a sterilised silver spoon was made to shell it out. This, however, was impossible, as it was discovered to be continuous with and infiltrating the surrounding cortex, and also the substance of the hemisphere about an inch below the surface and towards the front and middle line. The consistence of the tumour was semi-gelatinous, softer than the normal brain substance, and it was found easier to remove it with a silver spoon than in any other way. A considerable hæmorrhage occurred at the time, and as it was not well controlled by filling the cavity with cotton-wool, a series of fine silk threads were passed through the cortex for a depth of about three-quarters of an inch all round the affected area, except about an inch at the median line, and tied so that all the vessels in the affected area were controlled. The area was about two and a quarter inches in diameter. A free incision was then made through the cortex, all round, just within the line of ligature, and all the included part, brain and tumour, was taken away by means of the spoon. The tumour extended to the median surface of the hemisphere, and so a part of the marginal convolution and the quadrate lobule was removed, the falx being clearly exposed. In this way as much of the tumour as was visible was removed, but as the line of junction of healthy and diseased tissue was so indeterminate, it is not possible to say that the whole tumour was excised; it is, indeed, probable that it was not. At the close of the operation, the brain presented a large cup-shaped cavity, nearly two inches deep, and the size of half an orange. It is probable that the area removed comprised the upper part of the ascending frontal and parietal convolutions, the anterior part of the parietal lobule, and the adjacent portion of the marginal convolution. When all bleeding had ceased, the dural flap was very carefully stitched in position with fine silk. No bone was replaced. The scalp flap was brought in place by many horsehair sutures. The antiseptic employed during the operation was solution of mercuric perchloride (1 in 2000). The brain wound was constantly irrigated with the solution so as to keep it clear of blood. No marine sponges were used, and the operation area was kept free of blood, not by mopping or touching the brain, but by the stream of fluid. The patient was much collapsed when put back to bed, but this condition soon yielded to the ordinary treatment. The wound only needed dressing twice. The growth was found to be a mixed sarcoma with round and spindle cells. Aphasia and loss of power in the extremities of the right side followed the operation for a time. Four months after the operation, the patient was restored to her normal mental condition. Speech perfect. No headache. Some rigidity of joints of right hand and wrist, but movements on the whole good and useful. In the right lower limb loss of power over toes and ankle. Patient can walk without assistance or a stick, swinging the right leg, catching it on the ground sometimes.*

The following case, though not in the motor area,† is of great interest from the size of the growth, its less usual site, and the complication of hæmorrhage, eventually fatal:

The patient was affected with cerebral symptoms extending over eighteen months, consisting of left hemianopsia, which could only be accounted for by a destructive lesion in the neighbourhood of the gyrus cuneatus of the right occipital lobe, and locomotor disturbances, which appeared to be due to the pressure effects of a tumour on structures below the tentorium, and implied a growth of considerable size. Operation having been decided upon, a U-shaped flap was raised, and a 1-inch trephine applied at 1 inch above the occipital protuberance, and the same distance from the middle line, beyond the limits of both the longitudinal and lateral sinuses, and the bone removed until an oval opening 2¾ by 2½ inches was made, exposing a dura mater of a deeper hue than normal; section of this exposed the tumour, the outlying edges and base of which could not be reached in spite of further removal of the cranium; it was therefore incised and some of its softened granular and fatty-looking contents forced out. Its size was now somewhat diminished, and the forefinger could be passed between the cranium and tumour, and by its aid the delicate cellular attachments that held the mass in place were felt to yield easily, enucleation now became possible, and the base was finally reached. By next drawing the finger gently but firmly towards the cranial opening, the tumour was torn nearly completely in two, and its outer half lifted out; then the inner part was separated from the falx with the help of the finger-nail and withdrawn. Inspection of the mass showed that the tumour had been entirely removed, and that its probable attachment had been towards the posterior border of the falx; the tumour was a spindle-celled sarcoma, weighing 5¼ ounces, measuring 3¾ inches long by 2¼ inches wide, and being 8½ inches at its greater circumference. The falx was crowded over towards the left, and the tentorium depressed; two bleeding points were observed, one being in the region of the straight sinus, although not free enough for that vein, and probably belonging to the pedicle of the growth, while the other was apparently arterial. It being found that the hæmorrhage could be checked by direct pressure, the cavity was packed with 5 per cent. iodoform gauze, not too tightly, as it was assumed that the released brain would contribute additional pressure, and the ends of the strips were allowed, for easy extraction, to protrude from the lower angle of the scalp wound; the dura was partly united over the gauze by several loose sutures instead of being brought closely together, and the scalp wound closed with catgut sutures, a rubber drainage-tube being introduced under the skin up to the skull opening, and over these sublimated and iodoform peat bags were secured with gauze bandages. The patient soon showed symptoms of hæmorrhage, which could not be controlled by further packing, and death ensued thirteen hours later. Dr. Weir, in another case, would favour the application of hæmostatic forceps to the bleeding points, retaining them in place for twenty-four or forty-eight hours.

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* I must refer my readers to the original paper for a full statement of how far the usefulness of the limbs was impaired after the operation. The details are given with candid accuracy. In answer to my inquiry, Mr. Ballance informed me that the patient was living at the end of 1899, or more than four years after the operation but there was indication of return of the growth. Her death followed soon after.

† "Removal of a Large Sarcoma, causing Hemianopsia, from the Occipital Lobe of the Brain," by Dr. Birdsall and Dr. Weir: *New York Med. News*, April 16, 1887; ***Annals of Surgery***, vol. vi. No. 2, p. 149.

Growths from the Dura Mater.

The above are cases of growths from the brain itself.

Dr. Keen (*Amer. Journ. Med. Sci.*, 1888) has published a most interesting case of fibroma, weighing over three ounces, attached to the dura mater, which he removed successfully in a patient aged 27. The growth probably dated from an injury in childhood. It caused epilepsy, aphasia, complete hemiplegia, intense neuralgia, deafness, and great impairment of vision. Save for the eye and ear symptoms, all the other had passed away except slowness of speech and the epilepsy, and the last was much improved.*

Tubercular Growths.—As a rule these should only be attacked when there is good reason to believe that the growths are primary and single. The frequency with which they are multiple is treated of below (p. 290). But where a tubercular growth is threatening to cause blindness, severe headache, constant vomiting, &c.. it should be explored, and removed if possible. Mr. Horsley (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365) is strongly in favour of operation. Where a trial of medical treatment for four months fails, such tubercular nodules are probably densely fibrous with caseated centres. Age, no doubt, has an important effect here. Thus, in a child, owing to the yielding skull, the presence of a tuberculous mass may be long unsuspected or ill-marked.

Mr. Horsley (*Brit. Med. Journ.*, April 1887) has removed a tubercular tumour from the right lobe of the cerebellum.

Death took place nineteen hours later, the patient having only partially recovered consciousness. Generalised chronic tubercle was found in the viscera. The operation was here performed as a *dernier ressort.*

Mr. Bennett May (*Lancet*, April 16, 1867) removed a similar growth from the right lobe of the cerebellum of a child.

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* Prof. Macewen (*Lancet*, Aug. 11, 1888, p. 304) has published a case in which a tumour of the dura mater caused irritative lesions of the left frontal lobe. The patient was restored to perfect health, and died eight years later of Bright's disease.

The extreme bulging of the dura mater gave evidence of great intracranial pressure. The cortex appeared quite healthy, but at one spot palpation gave an ill-defined feeling of hardness. This spot being incised, the finger detected a hard mass nearly an inch below the surface. This was dug out with the handle of a small teaspoon. It was larger than a pigeon's egg, hard and horny outside and caseating in the centre. The hæmorrhage was trifling, but the patient sank from shock a few hours later. No necropsy was permitted.

Mr. Waterhouse (*Brit. Med. Journ.*, Oct. 1, 1898, p. 968) mentions with helpful candour three cases in which he had operated upon tuberculous tumours of the brain. In none was the tumour single. Two cases died within forty-eight hours of the operation, while in the third partial recovery for four months ensued, followed by death due to another tubercular tumour.

Time alone will show whether the belief of v. Bergmann is correct, that operation in these cases may favour the dissemination of the tubercle, giving rise to tubercular meningitis, and that it is not possible to enucleate tubercular matter in the brain with a sharp spoon as in the skin or bones.

These fatal cases of operation on cerebellar tumours, together with the one given at p. 285, afford me the opportunity of reminding my readers that the mortality after operation on parts of the cerebellum is higher than that for cerebral growths. Operations on the cerebellum are more dangerous than those on the cerebrum, owing to the more important surroundings of the former, and the vicinity of the centres for circulation and respiration (p. 251). Operations here are also more difficult, owing to the more restricted space (footnote, p. 255). Finally, the difficulties of exact diagnosis are here very great, not only as to the part of the cerebellum which is occupied by the growth, but also whether the growth is below or above the tentorium—*i.e.*, whether it is in the cerebellum or the closely contiguous occipital lobes.

A more recent case, which well illustrates the difficulty of diagnosis in tubercular lesions, was brought before the Edinburgh Medico-Chirurgical Society (*Brit. Med. Journ.*, Jan. 29, 1898, p. 303) by Dr. S. Thompson.

The child had suffered from tremor of the left arm and hemiparesis. Trephining was performed over the left motor area by Mr. J. Bell, but nothing was discovered beyond greatly increased intracranial tension. No relief followed the operation, and the child died within two days. At the necropsy, a strictly circumscribed rounded caseous tumour was found in the substance of the brain, immediately to the right of the medial line; it measured from 1½ to 2 inches in diameter, and had destroyed the anterior limb and genu of the internal capsule, the caudate nucleus, and most of the lenticular nucleus. It had not implicated the cortex.

Gummata.—Some have expressed the opinion that here surgical interference is uncalled for. Thus, v. Bergmann (*loc. supra cit.*) has criticised Mr. Horsley for having operated on such a case. While no one will operate on a gumma of the brain till a sufficient trial has been given to mercury and potassium iodide,* there is no doubt whatever that a syphilitic lesion may reach a stage here, as elsewhere, in which it has quite got beyond the reach of specific remedies. Such a lesion, if localisable and to be got at, should be attacked, because if left alone it will go on causing trouble indefinitely, and further, the compression and wasting of adjacent nerve-tissue which it will set up will in time become irreparable.

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* The American method of pushing this drug in large doses at frequent intervals, in milk (*Arch. of Medicine*, New York, Oct. 1884), is especially applicable here.

Mr. Horsley, who is of opinion (*Brit. Med. Journ.*, vol. ii. 1893, p. 1365) that cerebral gummata are not really cured by drugs, would certainly limit the trial of drugs to two months. He holds that gummata are here incurable, because there is always a certain degree of pachymeningitis around them, and that this is inevitably progressive.

The most interesting instance of operation in these cases is one of Prof. Macewen's (*Lancet*, May 23, 1885).

In a woman, aged 25, there was left-sided motor monoplegia of arm and leg, preceded by muscular twitchings and tingling sensations, without loss of sensation, due to syphilis, which resisted prolonged treatment. A cortical lesion of the right motor area, in the upper half of the ascending frontal and parietal convolutions, with probable involvement of the paracentral lobule, was diagnosed. A crown of bone over an inch in diameter, with its anterior border reaching to a point about half an inch behind the auriculo-bregmatic line, and its upper margin reaching to within half an inch from the centre of the superior longitudinal sinus, was removed. Its inner surface showed osteophytes. The dura mater was thickened and rough. Crucial flaps of this being reflected, a yellowish opaque effusion covered the brain, obscuring the convolutions and bridging the fissure of Rolando. This was very friable and came away in minute portions. Towards the upper part of the opening the brain offered resistance on palpation. This sensation proceeded from the interior of the brain, in the direction of the paracentral lobule, a layer of brain-tissue intervening between this more resistant structure and the finger. An incision being made through the upper part of the ascending parietal towards this firm structure, about two drachms of grumous fluid escaped. The resistance now disappeared, and cerebral pulsation was now, for the first time, feebly perceptible. The patient made a good recovery, regained sufficient power over the left side to enable her to walk two miles and to do her household work.

Mr. Waterhouse (*loc. supra cit.*) mentioned an interesting case of intracranial gumma, in which, in spite of the administration of potassium iodide and mercury for four weeks, and then potassium iodide in doses of 30 gr. t.d. for a further period of five weeks, the symptoms steadily increased. The patient became hemiplegic, then comatose. A large gumma was removed "from the left area of Rolando." Recovery was rapid and complete.

In the following case (Barton, *Ann. of Surg.*, Jan. 1889) syphilitic necrosis of the frontal bone existed before the trephining:

Owing to this, the gummatous thickening of the dura mater found at the operation was fœtid; this condition persisted, leading to hernia cerebri, and death about a month later. In this case, on incising the dura, characteristic gummatous deposit, yellow and cheesy, was discovered. It was very difficult to remove all this, as it was soft, friable, and firmly adherent to the walls of a cavity which it seemed to have hollowed out on the upper surface of the anterior lobe. The paralysis of the right arm and leg improved at first after the operation.

Cysts.—While the substance of the cerebellum appears prone to these formations, they may occur after injury over the motor area, as in the two following cases (Macewen, *Brit. Med. Journ.*, Aug. 11, 1890):

Epilepsy (Jacksonian) induced by Focal Facio-lingual Lesion—Removal of Cyst from Brain—Cure.

A man, aged 22, had epileptiform convulsions, each lasting from two to three minutes, with an average of over 100 in twenty-four hours. The convulsions were limited to the tongue, right facial muscles, and platysma. When they subsided the parts remained paralysed. Consciousness was retained. Eight years previously he received an injury to the head, after which his right arm became weak, though he was able to work. It was clear that an irritating focal lesion existed, confined to the base of the ascending convolutions, causing a Jacksonian epilepsy. At the operation, in the lower part of the ascending frontal a cyst about the size of a filbert was found, situated partly in the cortical and partly in the white substance of the brain, surrounded by a narrow zone of encephalitis. In manipulating the medullary substance during the removal of the cyst, the patient, while under chloroform, had a convulsion similar to those prior to the operation. The convulsion ceased with the removal of the cyst, and he never had another. The wound healed firmly under one dressing, the paralysis of the facial muscles soon disappeared, and the patient has since been constantly at work. The power of the right arm has also increased. Possibly the cyst might have caused, indirectly, slight pressure on, or had set up inhibitory action of, the middle part of the ascending frontal.

In another case, in which brachio-crural monoplegia was present, with late rigidity, these dating to an injury eight months before, Prof. Macewen removed a large, thick-walled, sub-dural cyst, containing clear fluid, which was pressing on the motor convolutions, together with a spicule from the inner table, which had penetrated the brain. The paralysis, with the contraction of the muscles, passed off to a great extent. The patient could neither walk nor stand before the operation; afterwards he could run about, and use his hand well, though there was still paresis in both limbs.

I have already (p. 227) alluded to the difficulty which is sometimes met with in securing the obliteration of these cysts, and the need, here, of frequently prolonged drainage.

Questions arising before attacking a Cerebral Tumour.—The chief of these are: (A) The existence of a growth. (B) The site of the growth. (C) The depth of the growth. (D) Is it single or multiple? (E) Its nature. (F) Is it a case for operation; and, if so, how far shall surgical interference be carried?

The above points, and the first five especially, must be decided with a physician; and it is to be hoped in future that physicians will invoke, at least, the opinion of the surgeon earlier than has hitherto been the case. In too many cases of cerebral tumour the operation has only been resorted to as a forlorn hope, a fact which is always to be considered when the mortality from operation in these cases is estimated.

A few words will be said here on the questions of the nature and multiplicity of the growth, and then as to the question of operative interference. I trust that the information given above, and the cases already quoted, will be helpful in deciding the above questions.

(E) *The Nature of the Tumour.*—Some help as to the varieties of growth most likely to be met with will be gained from the following table (Dr. W. Hale White, *Guy's Hosp. Rep.*, 1886).

Of 100 cases of cerebral tumour the proportions were as follows:

Tubercle	45
Glioma	24
Glio-sarcoma	2
Sarcoma	10
Carcinoma	5
Lymphoma	1
Myxoma	1
Cyst	4
Gumma	5
Doubtful	3
	100

Of the 45 cases of tubercle, the cerebrum was affected in 22, the cerebellum in 20 cases. The growth was multiple in 19, and single in 24 cases. In all the 45 cases one or more other structures than the brain were affected. Dr. W. Hale White concludes that not more than 3 tubercular cases were likely to be benefited by operation, and even in these the other organs were tubercular.

Of the 24 cases of glioma, of 10 only could it be said that they were not infiltrating. The cerebrum was the seat of the disease in 13 cases, the cerebellum in 4. In 1 case there were multiple gliomata in the brain, and in 2 others there were growths in other parts of the body.

Of the 10 cases of sarcomata several affected the dura mater in inaccessible positions; of the 5 cases which attacked the brain only, 1 alone could have been removed with any prospect of success. Of the remaining tumours none of the carcinomata or glio-sarcomata were amenable to treatment. Of the 4 cases of cyst 1 could certainly, and another possibly, have been operated upon; the myxoma was, and the lymphoma was not, amenable to operation; and of the 3 doubtful cases, 2 could have been operated upon. Dr. W. Hale White's summing up is as follows: "Thus we see that out of 100 cases of tumour of the brain, 10 might certainly have been operated upon, and 4 additional ones might possibly have been: so that in 10 per cent. of our cases we can hold out some hope of operative relief to our patients, provided that a correct diagnosis of the position of the growth be made, even so late as shortly before their death, whilst, of course, earlier in their histories many others might have been operated upon with a good prospect of success."

I will put side by side with these conclusions of Dr. W. Hale White those of another physician well known for his great clinical and pathological experience—Dr. Byrom Bramwell, himself an authority on this subject, the conclusions having been given at a debate on Intracranial Surgery, at the Medico-Chirurgical Society of Edinburgh (*Trans.*, vol. xiii., 1894, p. 180). Dr. Bramwell considered that the cases in which intracranial tumours can be successfully removed by the surgeon are rare, a consideration of the conditions present making it easy to understand why this must necessarily be the case. (1) In a certain but very small number of cases an intracranial tumour is not characterised by any symptoms during life which enable a positive diagnosis to be arrived at. (2) In some of the cases of intracranial tumour in which the symptoms—*e.g.*, headache, vomiting, giddiness, and double optic neuritis—distinctly show the presence of an intracranial tumour, there are no localising symptoms which enable the physician to determine in what part of the cranial cavity the tumour is situated. These cases constitute a not inconsiderable proportion of the whole. It is by no means uncommon to meet with large tumours in the temporo-sphenoidal and frontal lobes, the "silent areas" of the brain, which are unattended with any very definite and characteristic localising symptoms. The occipital lobe was formerly also thought to be a silent area, but it is now known that lesions in this situation produce homonymous hemianopsia, a most important localising symptom.* (3) In a few cases, in which there are localising symptoms, these give an erroneous impression as to the position of the tumour.

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* Dr. Bramwell points out that hemianopsia may be due to lesion in several different *situations*, viz., the cuneus, angular gyrus, and optic tract.

In support of this statement an instructive case is given in which, in a syphilitic patient, the local pain and tenderness and the localised character of the spasms, which commenced in the left big toe, clearly indicated that the tumour would in all probability be found in the cortex in the region of the foot-centre. The necropsy showed a glioma involving the right optic thalamus, the growth having encroached upon the posterior division of the internal capsule and apparently implicated the fibres to the left leg.

(4) In many of the cases in which the exact position of the tumour is clearly demonstrated, successful operative procedure is impossible or uncalled for. Thus, (*a*) in addition to tumours situated at the base, the basal ganglia, &c., Dr. Bramwell is inclined to include under this head a large proportion of tumours situated in the cerebellum, and for these reasons:—The surgeon can hardly hope to successfully remove tumours which involve the middle lobe of the cerebellum. Tumours which are situated in the lateral lobes are with difficulty reached, and the operation required for their removal is a dangerous one; the surgeon has to work in a very narrow space, and there is a risk of wounding the large venous sinuses, the medulla, the pons, &c. Further, it is often an extremely difficult or impossible thing to determine, during life, in which lateral lobe of the cerebellum the tumour is situated. (*b*) In other cases the tumour is so extensive and infiltrates such a large area of brain tissue that its complete removal is impossible. (*c*) In other cases the tumour is multiple. (*d*) In others it is malignant and of a secondary nature. (*e*) In some the cerebral tumour is complicated by associated lesions in other organs which contraindicate any operative interference. Thus, in not a few cases of tubercular growth of the cerebellum the lungs are also affected, and in some syphilitic cases the vessels either of the brain or other parts of the body are so extensively diseased that an operation is very hazardous. (*f*) Speaking of syphilitic growths, Dr. Bramwell, while admitting the good results obtained by very active drug treatment, was disposed to think that in many of the syphilitic cases in which the gumma is large and of some standing—cases in which a cicatrix must necessarily remain on the surface of the brain—operative procedure is advisable after the acute symptoms have subsided under the vigorous use of specific remedies, as the termination of many of these cases (the patients ultimately becoming useless members of society, or insane) is so deplorable.*

The above conclusions of Dr. Byrom Bramwell are based on an analysis of 82 cases of intracranial tumour which he had seen during life, and which he had examined post-mortem. In 77 out of the 82 operative interference was contraindicated. Of the 5 remaining cases he considered that in 2 the success of an operation would have been extremely doubtful; in the remaining 3 an operation might, he thought, have probably been attended with success.

But, while believing that there are comparatively few cases in which the surgeon can hope to successfully remove an intracranial growth, Dr. Byrom Bramwell would very strongly advocate trephining as a palliative measure in many of these cases.* "Thus, in not a few, the headache is intense, and it has been conclusively shown that in some of these cases sudden death takes place, apparently as a result of the pain and inhibition of the heart, a point to which Dr. Hughlings Jackson has directed attention. Again, in other cases in which the intracranial pressure is greatly increased, the patient dies either suddenly in an epileptic fit, or gradually as the result of failure of the respiration. Further, it must be remembered that in a large proportion of the cases of intracranial tumour the optic neuritis is intense, and that in not a few of them the optic neuritis, if allowed to continue, passes on to optic atrophy, and produces more or less, and it may be complete, blindness. Now, it has been conclusively shown that in some cases in which the operation of trephining has been performed both for tumour and abscess, the optic neuritis has speedily disappeared, in consequence, I believe, of the sudden relief of the increased intracranial pressure."

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* While admitting the force of this opinion, I am afraid that if surgeons follow Dr Bramwell's advice they will sometimes find. if they publish the results of their cases aft carefully watching them, that they have merely substituted one cicatrix for anoth (p. 230).

If I am right in saying that cerebral surgery has not done as much as was expected of it ten years ago, and that surgeons no longer attack cerebral growths with the enthusiasm and frequency of the same date, this proves that the enthusiasm was not based on careful and reliable reasoning, that operations for cerebral growths were performed without sufficient discrimination, and that the risks inseparable from this path in surgery were under-estimated—surgeons forgetting that while aseptic surgery had removed certain risks, others remained inseparable from the peculiar vitality of the part attacked. I refer especially to shock and collapse.

That the above remarks are fair and just will, I think, be allowed by anyone who refers to the last discussion on the Treatment of Intracranial Tumours, introduced by Dr. Ferrier in a speech of great ability (*Brit. Med. Journ.*, Oct. 1, 1898), in which he put the question of operation in the most favourable light possible. Dr. Ferrier mentioned, briefly, two cases in which the patients had survived the operation two years or more. Two surgeons only took part in the discussion, and two more successful cases of removal of cerebral growths were mentioned, but so briefly as to be of very little value. Dr. Byrom Bramwell, the president of the section before which the paper was read, stated that his "experience in regard to the success of operative procedure differed notably from that of Prof. Ferrier, for in none of his fourteen cases in which an operation had been performed had a tumour been successfully removed by the surgeon. The additional experience of the past few years had entirely confirmed the conclusions which he had published in the *Edinburgh Medical Journal* four years ago."

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* The relief that may be given by an exploratory, experimental, or palliative trephining in doubtful and urgent cases is well shown by one brought before the Clinical Society by Mr. Pearce Gould (*Trans.*, vol. xxxi. p. 286). The patient, æt. 41, had, six weeks before, suffered from severe headache without vomiting, followed by aphasia, right facial paralysis, and stupor deepening into coma. A two-inch trephine was used over the left face-centre. When the dura mater, which bulged into the wound without pulsation, was divided, the brain bulged still more. Puncture of this with a director in two or three directions proved negative. Four days after the operation the brain had receded below the trephine opening; three days later the patient was quite conscious. He was able to resume work in four months, but it is noted that six epileptiform fits had occurred; otherwise the health was good. My readers will note that, in addition to the trephining, the dura mater was opened. On the advisability of this step the authoritative opinion of Dr. Beevor and Mr. Ballance should be referred to (p. 294).

Speaking of the proportion of operable cerebral tumours, Dr. Ferrier considered it a fair estimate to say that only 7 per cent. of cerebral tumours are capable of being surgically dealt with. As to the recent statistics of the results of operation, he considered that when cases were collected from all sources, and therefore containing many factors not strictly comparable with each other—of which one, the personal equation of the operator, is exceedingly variable,—such a collection of cases gave 13 per cent. of complete recoveries, *i.e.*, the patients were alive at least a year, and in some cases several years, after the operation. Turning to the cases at the National Hospital for the Paralysed and Epileptic, where the operations were performed by Messrs. Horsley and Ballance, men of special skill in this branch of surgery, Dr. Ferrier pointed out that the cases operated on gave a percentage 16·6 of complete recovery.

Two well-known authorities on growths of the brain, Dr. Beevor and Mr. Ballance, thus reply to the question, "What do patients suffering from tumours of the brain gain from surgery?" (*Brit. Med. Journ.*, vol. i. 1895, p. 8. My readers will find the case on which this paper is based quoted from at p. 283):—

"It appears to us that in the several following ways enormous benefit may be given by operation: 1. The complete removal of a tumour, as in Mr. Horsley's case, of a small tubercular mass occupying the cortex in the region of the representation of the movements of the thumb.

"This patient, a man, æt. 20, suffered from frequent local fits, beginning in the thumb and forefinger, and from headache. From these symptoms he was completely relieved by the removal of the tumour and part of the cortex.—*Brit. Med. Journ.*, 1887.

"2. Partial removal of a tumour, as was probably done in the case on which this paper is founded.

"The operation on this patient relieved her of headache, vomiting, double optic neuritis, æsthesia, and from the greater part of her paralysis. The mental condition, which was very much deteriorated, was restored, the patient regaining her former cheerful condition.

"3. The drainage of a cavity in a cerebral glioma or sarcoma which cannot be removed. This is well illustrated by a case under the care of Sir W. Gowers and Mr. Ballance.

"The patient, aged 11, suffered from headache, vomiting, double optic neuritis, fits beginning in the thumb and followed by hemiplegia, and was practically relieved of all his symptoms, including moral deterioration (stealing), by this procedure. He lived for three years.

"4. The removal of bone and incision of the dura mater. The benefit resulting from this operation is well shown by a case which was under the care of Dr. Buzzard and Mr. Ballance.

"A woman, aged 41, was admitted with symptoms pointing to tumour of the internal capsule, namely, hemianæsthesia, nearly complete hemiplegia, double optic neuritis with failing sight, and severe headache with agonising paroxysms. In one of these paroxysms she became comatose, and was evidently dying, it was thought from hæmorrhage into the tumour. The above operation was at once performed, and the relief of the urgent symptoms was immediate; and in a month's time the report states that there was no headache, vomiting, or optic neuritis, and some return of power and sensation had already occurred, with improvement of sight and restored mental condition.

"5. Removal of a considerable area of bone without opening the dura mater is, we believe, considered by some to be adequate to relieve the classical symptoms of tumour. It is true that the dura bulging through the opening in the skull indicates that there is a relief of pressure, but what we have to deal with is tension within a practically inelastic membrane, and the intra-dural space can hardly be materially increased while the dura is intact, and the opening in the skull is comparatively small. The sac of the dura cannot be distended to its full extent while the cranium is intact, and so when bone is removed its foldings are flattened out. A considerable fall in pressure can only be obtained by taking away a large area of bone, and in tumour cases when this is done the dura still bulges under much *plus* pressure. As we have known of no case in which the removal of bone alone has relieved the pressure symptoms, we should advise that the dura should always be opened; another reason of great import being that the cortex might be involved without any of the type signs being present. . . . . We would conclude this paper with the question, How soon should one of the preceding operations be performed? When the type symptoms are present, it is quite certain that no delay is desirable after a fair trial has been given to antisyphilitic remedies, and we should limit this time to six weeks or two months (Horsley, *Brit. Med. Journ.*, 1893). The main difficulty arises when the symptoms are not typical; and it is to be borne in mind that large slowly-growing tumours may be present without any symptoms which are unequivocal. As an instance of this a case may be referred to which was under the care of Mr. Horsley and Dr. Beevor. The patient had occasional fits with unconsciousness, beginning in the corner of the mouth, six years before other symptoms arose which justified operation, and then the tumour was found to be so situated that it could not be removed without producing aphasia. It would be easy to mention other cases illustrating the same point. In any case where the typical signs of tumour are absent, and where the fits always begin with the same localised warning, and are attended with loss of consciousness, the question is, Are these fits due to idiopathic epilepsy, or are they due to a tumour? And we should say that no operation is advisable, other signs of tumour being absent, unless the paralysis which follows the fits is permanent—that is, not recovered from in the course of a few days—or unless the fits occur very frequently. While it is impossible to lay down absolute rules for the treatment of these cases, it would appear that occasional fits, beginning locally, followed by loss of consciousness, and attended only by headache, would not justify an operation; but that any other combination of the type symptoms—headache, purposeless vomiting, optic neuritis, especially with failing sight, localised fits, and permanent paralysis—would render surgical operation advisable."

We come lastly to the most important of the questions from a surgeon's point of view: (F) **If it be a case for operation, how far shall surgical interference be carried?**

The following points are worthy of consideration before we come to a conclusion: (i.) *That we are here dealing with a peculiarly vital part.* I think that any candid surgeon, acquainted with the history and progress of his profession, will allow that in two directions the progress of antiseptic surgery has been less brilliant than might have been expected when its other triumphs are considered. The two referred to are: removal of cerebral growths, compared with the other advances of cranial surgery; and the operative relief for acute intestinal obstruction, compared with the brilliant successes in other branches of abdominal surgery. The explanation of this is not far to seek. I maintain it lies in the fact, to which due weight has not been attached, that both the brain and the small intestine (with its association with the mesentery, solar plexus, &c.) are peculiarly vital structures, and that, however great advances may be made, this fact will remain unchanged. Along with the above go several other points. (ii.) *The operator should be a man well versed in general surgical technique of the present day, and with experience in brain surgery.* Nowadays, especially when the line between the hospital surgeon, who is habitually operating, and the general practitioner, whose experience is infinitely less, is, as regards operations, very much less sharply defined than it was twenty years ago, I would speak emphatically on this point. (iii.) *The operator, however experienced, should know when to stay his hand.* In these cases of cerebral growths, involving peculiarly vital parts—growths, often of much longer existence, and of larger size than has been suspected, nearly always difficult to identify, and especially so if sub-cortical—the surgeon may very readily be led on and on to do too much for his patient's strength. Happily, this is, in a measure, met by adopting the advice which Mr. Horsley and Prof. Macewen (*Brit. Med. Journ.*, vol. ii. 1893, p. 1367) have given, that the operation had often best be divided into two stages (*vide infra*). Again, the same authorities and many others—*e.g.*, Dr. Ferrier and Dr. Byrom Bramwell—have shown that where removal is out of the question, a palliative trephining may, by the relief it gives to pressure, remove for a time such distressing symptoms as vomiting, headache, advancing optic neuritis,* &c.

Chief Difficulties and Dangers in Operations in Cerebral Tumours.—Some of these are enumerated now; they will be more fully dealt with later (p. 304).

(1) Sufficient exposure of the growth. (2) Embarrassments with the anæsthetic. (3) Hæmorrhage. (4) Difficulty in detecting the growth. (5) Difficulty in isolating the growth.

(1) Sufficient exposure of the growth.

(2) Not only may much bone require removal (as in the case recorded, p. 284), but the patient's condition, from a tendency to coma, failing pulse and respiration, aided by the effects of the anæsthetic (p. 203), may seriously embarrass the surgeon by cutting short the time needful for sufficient removal of the cranial bones. I have spoken before (p. 194) of the liability of patients, with increased intracranial pressure caused by growths, to sudden and unexpected death. Dr. Ferrier (*Brit. Med. Journ.*, Oct. 1, 1898, p. 965) gives two

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* This relief is due to the lessened tension after the free escape of cerebro-spinal fluid, or to the growth exerting its pressure in the line of least resistance—the opening in the skull and dura. Dr. Ferrier advises, if no guide to the site of the trephining—*e.g.*, pain on deep pressure, &c.—be present, that the palliative trephining be made with a free opening over the occipital or frontal region. A free opening has the disadvantage of leading to a hernia cerebri; this must be treated by careful pressure with a leaden plate, and strict asepsis.

instances in which such sudden death occurred. In one a growth, the size of a hen's egg, was found at the necropsy, under the cortex in the area of Rolando; while in the other the symptoms pointed to a growth in the upper part of the same area. Dr. Ferrier points out that had these deaths occurred on the operating-table they would undoubtedly have been attributed to the operation.

(3) Hæmorrhage (p. 309).

TREPHINING FOR MICROCEPHALUS, IDIOCY, ETC. LINEAR CRANIECTOMY.

Lannelongue's suggestion of invoking the aid of surgery in the treatment of imbecility (*Bull. de l'Acad. des Sciences*, 1890, and *Union Médicale*, t. i. 1890, p. 42), &c., aroused much interest, and in the **last few years a large number of cases have been submitted to** craniectomy, with a view of either removing some morbid condition or relieving pressure on the brain, or in some way stimulating its development. Like several other advances of modern surgery, it has not been based on the sound foundation of pathology or common sense. I refer to the pathological conditions and their hopelessness, and also to the poor vitality of these patients and their unfitness to be subjected to severe surgical operations. The results, as might have been expected, have been very unsatisfactory.

Before we can decide how far such operations are likely to be established procedures, we must consider what **pathological conditions are likely to be met with, and how far they are remediable.** These appear to be (Starr).—(i.) **Microcephalus,** whether due to premature closure of the cranial sutures (Virchow), or secondary to mal-development of the brain (Broca). In the following conditions the brain is at fault, with or without marked microcephalus, and sclerosis and atrophy are met with in a varying degree in nearly all. (ii.) **Porencephalus.** By this is meant a localised atrophy, leaving a cavity in either cerebral hemisphere, which may be deep enough to open into a lateral ventricle. (iii.) **Mal-development and atrophy of the minute structure of the cortex** of the hemispheres, without any gross defects. (iv.) **Meningo-encephalitis,** leading to thickening of the meninges and atrophy of the cortex. (v.) **Cysts** producing atrophy from pressure. (vi.) **Hæmorrhage** on or in the brain. (vii.) **Hydrocephalus.** This last will be considered separately (p. 301). It is obvious, first, that many of the above are only to be recognised by exploration, and that most of them, if found, are hopeless of improvement. Thus it is clear that where sclerosis and atrophy are present to a marked degree, in cases of porencephalus, where one entire hemisphere is converted into a cystic cavity surrounded by shrunken brain-tissue and thickened arachnoid, interference will be futile. In the latter it may be fatal by the shock that will follow on the withdrawal of a relatively large amount of cerebro-spinal fluid. We have seen (pp. 226, 228) that in cases where a cyst is found a good deal may be done by surgery, and the same may perhaps be the case where a surface hæmorrhage is not too firmly organised. Microcephalus, the condition for which linear craniectomy was introduced, deserves a separate notice.

Dr. J. Griffiths, of Cambridge (*Proc. Med.-Chir. Soc.*, March 8, 1898), shows that the skulls of microcephalic idiots may be classified under the following groups:—(*a*) The skull is of normal shape and outline, but small, ill-developed, and ill-filled. There is no premature synostosis of the sutures. (*β*) The skull is not only small, but deformed from unequal growth. Whether this deformity is due to primary disease of the bones or premature synostosis of several of the sutures, or whether it is due to disease as well as defective growth of the brain, is still an open question. As in one form of microcephaly the brain itself is generally defective in the power of growth, its development having been arrested at an early period of embryonic life, and as in the other there is, in addition to arrested development, disease of the brain substance, and as the existence of cases of microcephaly in which premature synostosis has been able to impede or dwarf the growth of a normal brain is, as yet, quite hypothetical, craniectomy can be productive of no permanent good, the original fault being in the cerebrum and not in the skull.

In recommending operative steps the wise surgeon will be careful not to be too sanguine, remembering the nature of many of the conditions which he may meet with, and the impossibility of improving some of them. There is great weight in the words of the late Prof. Agnew, that, "Nothing perhaps exhibits the enthusiasm of modern surgery more than these attempts to coax an undeveloped idiotic brain to execute the orderly functions of intelligence."

Furthermore it must be remembered that here, as in trephining for epilepsy (pp. 223, 230), cases have been reported much too soon to be looked upon as successes. One of the most instructive proofs of this is given by M. E. Blanc (*Loire Méd.*, Dec. 15, 1898; *Epit. Brit. Med. Journ.*, Jan. 14, 1899). He gives later details regarding seven cases in which craniectomy was performed for microcephalic idiocy. The first two cases were operated on in 1891, the third in 1893, and the other four since. In all there was the most evident and immediate improvement, then the condition became stationary, and finally there was a return to the primitive condition. The flashes of intelligence which had been noticed were extinguished, the face became expressionless; signs of excitement reappeared, such as weeping, laughing, inarticulate cries, and convulsions; also walking became difficult and hesitating, as it had been before the operation. All the ground so slowly and painfully gained was lost. M. Blanc is of opinion that the difference in the results is due to the nature of the microcephalic idiocy. When one has to do with primitive microcephaly (the most frequent form) one cannot expect a permanent good result from surgical intervention, for the arrest in brain development takes place at the fourth month of intra-uterine life. When, however, one has to do with post-embryonic or later microcephaly (which is the exception), it is permissible to give a more hopeful diagnosis. M. Blanc is not favourably impressed with Doyen's temporary hemi-craniectomy or Laboulay's mobilisation of the cranial vault. If the microcephaly is of the later variety, the ordinary procedures are sufficient; if it is primitive, no intervention, however extensive, will be successful—it is not the cranium but the brain which is at fault. The second point is, that we are here dealing with very vital parts in patients of poor vitality, and that, unless the surgeon is careful not to attempt too much, death from shock will be a very present danger.

Thirdly, many fatal cases have not been published, and we do not know what the mortality of this operation really is. Dr. Jacoby published (*New York Medical Record*, May 1894) a collection of 33 cases, of which 14 had died and 19 recovered, giving the very high death-rate of 42 per cent. Dr. Dana (*Pediatrics*, March 1896) collected 81 cases, many of which had been recorded in Dr. Jacoby's article. Of these 81, 24 died, 35 were improved, and 24 showed no improvement. The death-rate of this collection of cases was 29 per cent.

Before leaving the question of the advisability of operative interference in microcephaly, I will quote the conclusions of Prof. Keen, of Philadelphia—conclusions which are most valuable on account of his long experience in operative surgery, and especially from his well-known skill in operations on the head and brain. Prof. Keen has performed craniectomy in 18 cases of microcephaly, the youngest patient being eighteen months, and the oldest seven and a half years old. In 5 cases the operation was fatal; in 6 cases slight improvement followed; in 7 none at all. Prof. Keen's conclusions are as follows:—No good can be expected from the operation in cases with average-sized heads, nor in those with extreme microcephaly, nor where the patient is over seven years old. In one case a restless, mischievous idiot was transformed by the operation into "a quiet, sleepful child"; but the improvement, when there is any, is usually slight. Much depends on special education after the operation. In some cases of moderate microcephaly the operation is justifiable, and in a small number of cases a slight improvement will follow; but in the majority there will be no result, good or bad; while in a definite proportion (15 per cent.) "the operation will happily be followed by death" (*Journal of Nervous and Mental Diseases*, Feb. 1898).

Operation.—We will take first a case in which there is marked microcephalus, in which perhaps premature ossification is the cause of the trouble. Lannelongue (*L'Union Médicale*, Juillet 8, 1890) operated in his first case as follows: Having made an incision through the scalp and pericranium just to the left of the sagittal suture, a small circle of bone was removed with a trephine, a finger's breadth from the suture; from this as a starting-point, a narrow strip of bone was cut out parallel with and to the left of the sagittal suture, extending from the coronal to the lambdoid suture. The periosteum was not replaced. Mr. Horsley removes the periosteum over the bone to be excised. This last step he effects by making parallel saw-cuts backwards and forwards from the trephine opening, and then removing the bone between the saw-cuts with sharp-pointed bone-forceps,* the dura mater being first detached with an elevator. In some cases, in addition to the removal of bone parallel to the sagittal suture, a second narrow strip has been removed over the corresponding fissure of Rolando.

Dr. Roswell Park (*Med. News*, Dec. 2, 1892) adopted this step in two cases, in one with great improvement, in the other with practically no good result. Mr. Horsley did the same in his second case, but considers it unwise and doing too much at one time. His case died with hyperpyrexia attributed to disturbance of "the cortical thermotaxic centres." Mr. Horsley, who was the first to bring the subject of craniectomy in these cases before the notice of English surgeons (*Brit. Med. Journ.*, 1891, vol. ii. p. 579), operated on another case which at first showed some improvement. Later on, this child has been operated on four times. Dr. Telford Smith (*Journ. Ment. Science*, vol. xlii. p. 64) considers that there is no improvement in the mental condition which can be attributed to the operation.

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* De Vilbiss's forceps (p. 308) would be very useful here.

In other cases there is distinct asymmetry or evident mal-development of part of the skull, especially the frontal region, as in a case of Dr. Starr's (*loc. supra cit.*, p. 148), where a marked difference could be seen between the size of the frontal bone and that of the posterior part of the skull. Dr. McBurney operated as follows:

The object in view being to allow of growth of the frontal lobes, it was thought best to lift the bone away from the brain on both sides. The left side was first operated on, and, two weeks later, the right. A long semilunar incision was made in the scalp, from the forehead near the temple backwards to the mid-parietal regions, its convexity being upwards. A small trephine-opening was made at the summit of this incision, and, with this as a centre, a groove was chiselled in the bone, first downwards and forwards, then downwards and backwards. Thus, an omega-shaped groove in the skull was cut. The bone was then gently prised up, the short limb of the omega between its ends being broken. Thus a bony flap with scalp attached was raised about an inch away from the dura. The dura was not opened. The wound was dressed so as not to make pressure on this flap. The operation was followed by some improvement, but later information is much needed on this point.

Dr. Griffiths (*loc. supra cit.*) and others have established artificial lambdoid sutures, operating at intervals, first on one side of the skull and then on the other.

Whatever operation is performed, it should be completed as speedily as may be, and care should be taken not to do too much at one operation. Every precaution should be taken against shock, and if the hæmorrhage has been severe it may be useful to resort to infusion of saline fluid (p. 107).

Dangers of the Operation.—These are chiefly—(1) Shock. (2) Hæmorrhage. Hæmorrhage from the scalp may be met by an india-rubber bandage passed around the head (p. 191), but other bleeding may be met with.

Dr. Shaw and Dr. Dendy, of Aylesbury, published with full detail (*Lancet*, vol. ii. 1895, p. 1423) a case of linear craniectomy which is instructive on this point. At the time of the operation on the right side, when the strips of bone had been removed, the dura mater did not give much evidence of tension. When, however, a month later the left side was operated upon, there was no doubt about fluid existing beneath the dura. A puncture was followed by a jet of blood. Exploration showed that the greater part of the left hemisphere was occupied by a huge blood-cyst. Marked collapse followed, and the child died five hours after the operation.

(3) Injury to the dura mater, especially adherent, in children. (4) Septic changes in the wound; these patients, restless and ill-regulated in their behaviour, may make the maintenance of asepsis very difficult, especially in older and thus less easily managed cases, by tearing off their bandages. (5) Hyperpyrexia of obscure origin (p. 298).

TREPHINING IN GENERAL PARALYSIS OF THE INSANE.

As this operation has been recommended on the authority of Dr. Claye Shaw (*Brit. Med. Journ.*, vol. ii. 1889, p. 1090; vol. ii. 1891,

p. 581) and Dr. J. Batty Tuke (*ibid.*, vol. i. 1890, p. 8) it deserves mention here; but time alone will show whether I am right in saying that it does not appear one to deserve encouragement, even as a palliative step. It must not be forgotten that here is no morbid condition which can be cured; that the excess of fluid—the removal of which, and so the relief of tension, is the object of trephining—is variable; and while it is clear that the benefit given by the operation has been only temporary, it must be remembered, as pointed out by Dr. J. Adam (*Brit. Med. Journ.*, vol. ii. 1889, p. 1187) and Dr. R. Percy Smith (*ibid.*, vol. i. 1890, p. 11), that temporary periods of spontaneous marked improvement are not uncommon. The operation promises to give most relief where marked headache or convulsive seizures are present and are not relieved by other treatment. Where the disease is advanced, and where the history of alcoholism is marked, the step should not be entertained.

It is interesting for surgeons to note that at the debate on Intracranial Surgery at Edinburgh in 1894 (*Trans. Edin. Med.-Chir. Soc.*, vol. xiii. p. 153), such authorities as Dr. Batty Tuke and Dr. Clouston were at distinct variance both as to the pathology and the operative treatment of this disease. Dr. Tuke held that excess of fluid was certainly present. "In the cases in which he had recommended drainage by operative measures, obvious indications of pressure had been present, for when the disc of bone was removed the dura bulged much further into the hole than was observed in traumatic cases where trephining was performed for the relief of local pressure. In all the seven cases he had seen operated on, a layer of fluid was distinctly noticeable existing between the arachno-pia and the true pia, varying in different cases, but always detectable by the finger." In all the seven cases immediate relief was obtained, and was maintained as long as the drainage, which should be slow and gradual, was continued.

Dr. Clouston, on the other hand, said that "from his views of the essential nature of the disease, and looking to its pathology and the course of all recorded cases, he was most sceptical as to any possible cure from any kind of operation whatever. He did not agree that the two cases reported by Dr. Claye Shaw and Dr. Batty Tuke were in reality cures, even if they were cases of general paralysis at all. In the diagnosis of early general paralysis they were all apt to make mistakes. With regard to the improvements recorded after operations, he did not think they were any more decided than they saw in ordinary cases of paralysis that were left to themselves. They saw such short improvements in a great many cases. He was absolutely sceptical as to the existence of general pressure at all in general paralysis. As regards the contested question as to whether the fluid under the arachnoid meant pressure or not, he held that it meant want of pressure, and was merely compensatory after the brain had undergone atrophy."

Until authorities of special experience in this disease can agree on its pathology, and especially on points of such practical importance as the presence of fluid, the part which this plays in the disease, whether it is primary or secondary, &c., the thoughtful surgeon will hold his hand.

Operation.—In the few cases recorded the trephine has been applied in the parietal region. Defined headache may help to localise its application. The dura mater should be opened and removed sufficiently to allow of free escape of fluid, and the pia mater, if œdematous, may be punctured. Draining should be provided by horsehair or a tube, if needed. Dr. Claye Shaw has advised (*Brit. Med. Journ.*, vol. ii. 1891, p. 583) tapping and draining the lateral ventricles. This step is described below. It would probably be difficult to keep up drainage for any useful period in many of these patients, and the histories of general paralysis of the insane do not suggest the existence of much intracranial pressure such as surgeons are familiar with in hydrocephalus. In conclusion, while I should add that I have no personal experience of the operation, it does not seem to me to be one based on sound pathological evidence, or justified by success.

TREPHINING FOR DRAINAGE OF THE VENTRICLES.

It is well known that distension of the ventricles with a fluid largely cerebro-spinal does occur, causing symptoms closely similar to those of cerebral growth. It is natural, therefore, as treatment by medicine is useless, that surgery should be resorted to. Unfortunately, in the majority of the cases, the distension of the ventricles is only secondary to some disease in the cerebellum, corpora quadrigemina, or crura cerebri, pressing on the veins of Galen, or, as Mr. Hilton showed years ago,[*] to occlusion of the cerebro-spinal opening in the fourth ventricle—all forms of disease equally hopeless. In a few cases the collection of fluid is due to meningitis, often tubercular. Every operating surgeon of any experience has tapped the ventricles through a lateral angle of the anterior fontanelle, with the result of often giving marked relief, obviously, from the nature of the cause, only temporary, convulsions and coma carrying off the patient after a varying interval. The antiseptic method has not aided us here, owing to the conditions at the root of the mischief; withdrawal of the fluid slowly by a Southey's tube has been equally unsuccessful.

With a view of ensuring more gradual drainage and some alteration in the lining membrane, the following operation has been performed:

Trephining for Drainage of the Lateral Ventricles.—Prof. Keen, of Philadelphia, was the first to formulate the operation of trephining and puncture of the lateral ventricles, as distinguished from the ordinary puncture, which had long been done, in hydrocephalus (*Med. News*, Dec. 1, 1888; Mar. 9, 1889; Sept. 20, 1890).

In one case the patient was a boy, aged 4, with hydrocephalus and rapidly developing blindness, due, as proved later, to a growth of the cerebellum pressing on the straight sinus. The left ventricle was reached by trephining at a spot 1¼ inch above and behind the auditory meatus[†] and by puncturing the brain with a needle directed towards a point 2½ inches above the opposite meatus. At a depth of about 1¾ inch resistance to the needle suddenly ceased, and cerebro-spinal fluid escaped. Three double horsehairs were then introduced and the needle withdrawn. Drainage thus established was kept up for fourteen days, when the horsehair was replaced by a drainage-tube.[‡] On the twenty-eighth day after the operation, the symptoms returning, a corresponding operation was performed upon the right side, and a drainage-tube passed directly into the ventricle. The child died on the forty-fifth day.

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[*] *Rest and Pain*, lectures ii. and iii. Mr. Hilton first noted this fact in 1844.

[†] Some consider this spot too near to the lateral sinus, and advise placing the trephine half an inch higher.

[‡] This is best done by means of a Lister's sinus-forceps.

The second and third cases died four days and four hours respectively after the tapping. In the second the operation was just like that in the first, but as, on replacing the horsehair drain by a tube, the escape of fluid appeared to be too free, the tube on each side was plugged. Then convulsions set in, and it being concluded that too much fluid had escaped, warm water was allowed to run into the ventricle. This was done repeatedly, the introduction of an ounce of warm water each time arresting the convulsions; but the child soon died.

Mr. Mayo Robson (*Brit. Med. Journ.*, 1890, vol. ii. p. 1292) was more successful, but it will be seen that his case differs widely from those in which fluid usually collects in the ventricles.

The case was probably one of meningitis, localised to the left posterior and middle fossæ, with otitis media of the left ear. Right hemiplegia supervened, and, in the hope of finding an abscess, the skull was trephined over the situation of the motor centre for the arm. An exploring needle failing to find pus, the needle was pushed into the lateral ventricle, withdrawing six drachms of clear fluid, on which pulsation returned in the brain. The hemiplegia gradually disappeared, and six months later the child was well, save for occasional recurrence of slight convulsive seizures limited to the right arm.

As will be seen at once, this case is totally different from the cases which usually call for tapping and drainage of the lateral ventricles. Thus, in this case but one ventricle was affected, the surroundings were much more healthy, and there was no general internal compression of the brain. In another case Mr. Robson drained one ventricle for hydrocephalus following on treatment of spina bifida by Morton's fluid. This case, as is the rule, died in convulsions a few days later.

The only case which recovered from the operation is one of Broca's (*Rev. de Chir.*, Jan. 1891), but the date at which the report breaks off makes it of very little value.

The patient, aged 4, was an imbecile suffering from hydrocephalus, and a contraction of the upper extremity, which had followed on convulsions. The skull was trephined at the spot chosen by Prof. Keen, and sixty grammes of fluid withdrawn. A drainage-tube passed through the cannula was allowed to drain into the gauze dressings, which were changed every day or two. On the sixteenth day very marked improvement was noted, the contraction in the right upper extremity having disappeared. The fluid gradually ceased to drain away, and by the fiftieth day the wound had entirely healed, and the child was discharged very much improved physically and mentally.

Intracranial Drainage of the Lateral Ventricles by making a Permanent Communication between the Ventricles and the Sub-dural Space.

An ingenious method of intracranial drainage in chronic hydrocephalus was brought before the Clinical Society by Dr. Sutherland and Mr. Watson Cheyne (*Trans.*, vol. xxxi. p. 166). Other modes of drainage having proved unsatisfactory, the following operation, based on the experiments of Dr. Leonard Hill (*Physiology and Pathology of the Cerebral Circulation*, 1896), was performed with a view of establishing a permanent communication between the ventricles and the sub-dural space.

The child, æt. 6 months, was markedly hydrocephalic, emaciated, anæmic, with intelligence practically undeveloped, and quite blind. The hydrocephalus and the basal meningitis, which proved fatal, were attributed to congenital syphilis. A curved incision, about an inch and a half long, having been made over the left lower angle of the anterior fontanelle, the skin and deeper tissues were turned down from off the dura mater. A small incision was then made in the dura mater. To form a drain, a bundle of the finest catgut, containing some sixteen strands and about two inches long, had been prepared, one end being tied together and the other being free. As soon as the dura mater was incised, the tied end of this bundle was pushed by means of sinus-forceps downwards and backwards, between the brain and dura mater, for about an inch. The other end of the drain, which projected through the slit in the dura mater, was then pushed by means of the sinus-forceps through the substance of the brain (very thin at this spot) into the expanded lateral ventricle. Clear fluid, about an ounce in amount, escaped. One end of the drain being thus left in the sub-dural space, and the other in the ventricle, the opening in the dura mater was closed with three fine sutures, and that in the skin by a continuous silk suture. By this step any risk of persistent oozing of cerebro-spinal fluid, and sepsis, was avoided. On the fifth day, when the wound was healed, it was noticed that the head was distinctly smaller in all its dimensions. This diminution in size continued, but without any improvement as regards the child's intelligence or vision. Symptoms of basal meningitis began to appear nine weeks after the operation, and death followed three weeks later. The necropsy showed the opening into the left ventricle made at the operation, and an absence of inflammation around the remains of the catgut drain. While the lateral ventricles were not distended with fluid, a considerable quantity of fluid remained in the sub-dural space. Expansion of the brain, the factor necessary for the removal of the intracranial fluid, had not taken place.

The following remarks by Mr. Watson Cheyne explain the *rationale* of the operation and the cause of its failure. The conclusions drawn by Mr. Leonard Hill, especially that which shows that "fluid escapes directly into the veins from the sub-dural and sub-arachnoid space at any pressure above the venous pressure," suggested the line of treatment which has just been described. "If we could only establish a permanent communication between the ventricles and the sub-arachnoid space, then, no matter how much fluid was poured out into the ventricles, it would be at once carried off by the veins, and thus all injurious pressure, whether intra- or extra-cerebral, would be removed, and the brain would be free to develop if it could. And further, by this means matters would regulate themselves in a way that no method of external drainage could effect, for when the communication was once established the rest could be left to nature. The result of the operation fully confirmed these expectations. The disappearance of all abnormal intracranial pressure was complete and permanent from the time of the operation. The shrinking in the size of the skull was steadily progressive until a point was reached when the bones were overriding, and further diminution in the capacity of the cranium was checked. The factor necessary for the complete removal of the intracranial fluid, namely, the expansion of the brain substance, was apparently absent in this case, and the result was, that though the ventricles were completely drained, a considerable quantity of fluid remained in the sub-dural space, as shown at the necropsy; but, as there was no increased tension, it was not the presence of this fluid which hindered the expansion of the brain."

Drainage of the Fourth Ventricle.—This was performed by Mr. Stiles in a case of acquired hydrocephalus due to basal meningitis (Bruce and Stiles, *Trans. Edin. Med.-Chir. Soc.*, 1898, vol. xvii. p. 73).

The patient, æt. 13, with well-marked evidence of congenital syphilis, presented symptoms of chronic basal meningitis—viz., irregular pyrexia, persistent head-retraction, nystagmus, gradually increasing blindness, great weakness and emaciation. This condition becoming critical, with marked cyanosis and rigors, it was decided to open the fourth ventricle and drain the ventricular system. Mr. Stiles trephined in the middle line over the lower part of the occipital bone, including the margin of the foramen magnum, and enlarged the opening by forceps. The dura mater was opened after the occipital sinus had been secured between two ligatures. Separation of the two tonsils of the cerebellum allowed of the escape of much cerebro-spinal fluid. Immediate improvement followed the operation, and lasted for a week, when there was again a rise of temperature. Death occurred, with hyperpyrexia, nineteen days after the operation, much cerebro-spinal fluid having drained away in this interval.

OPERATIVE PROCEDURES ON THE BRAIN, CHIEFLY FOR THE REMOVAL OF GROWTHS.[*]

Preparation of the Patient.—The day before the operation the patient's head is shaved, cleansed with soft soap, and then ether or turpentine. It is then soaked for three minutes with a solution of biniodide of mercury in methylated spirit (1 in 500). This is washed away with a watery solution of biniodide (1 in 2000), and an antiseptic dressing applied. The position of the lesion may be ascertained by measurements taken with every precaution, and indicated on the scalp with silver-nitrate solution. Finally, the patient has the usual purgative administered the evening before, followed by an enema on the morning of the operation. Any course of bromides should be suspended for a week before the operation.

Anæsthetic.—If not contraindicated, a hypodermic injection of a quarter of a grain of morphine[†] is given, and then chloroform is administered. The object of giving the morphine is twofold: in the first place, it allows of the performance of a prolonged operation without the necessity of giving a large amount of chloroform, the amount actually used in an operation lasting two hours being very small.

The second reason is perhaps the more important: that this drug causes well-marked contraction of the arterioles of the central nervous system, and that consequently an incision into the brain is accompanied by very little oozing if the patient be under its influence. Mr. Horsley has not used ether in men, fearing that it would produce cerebral excitement; chloroform, on the contrary, producing well-marked depression. But if much tendency to shock existed, or if it were needful to keep the head raised, the above theoretical considerations would be disregarded in favour of the safer anæsthetic,[‡] or the A.C.E. mixture.

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[*] Many other operations on the brain—*e.g.*, for abscess, removal of bullets—have been already fully considered. Several instances of removal of growths have also been given in the preceding pages. Mr. Horsley (*Brit. Med. Journ.*, Oct. 9, 1886, and April 23, 1887) first insisted on the majority of the details above given.

[†] In one case, a child of 4, one-twentieth of a grain was found amply sufficient. The advisability of a preliminary injection of morphia has been a good deal disputed. Dr. F. W. Hewitt, in his most careful work on Anæsthetics, p. 274, thus puts the matter succinctly: "In feeble or exhausted patients, in those who are lethargic or semi-comatose, and in those with any respiratory difficulty, I am convinced that the advantages obtainable from morphine are not sufficiently weighty to counterbalance the risks attendant upon its employment." When morphine is contraindicated, ʒj.-ʒij. of the liquid extract of ergot may be given half an hour before the operation, as advised by Prof. Keen.

[‡] Attention is also called to the startling rapidity with which a patient who has roused up in the middle of one of these prolonged operations, can be sent off again in a moment, with only a few whiffs of the drug, and that thus it is very easy to give too much in a brief space of time. Mr. Horsley expresses a strong opinion that this sensitiveness to the action of the anæsthetic is more marked when the dura mater is opened.

Treatment of the Wound.—The high mortality accompanying trephining being largely due to septic meningitis, strict antiseptic precautions will alone give safety.

Line of Incision.—Mr. Horsley disapproves of the ordinary crucial incision as inconvenient at the time, as the four flaps have to be held out of the way, and later on their point of meeting, a weak spot, may aid the formation of a hernia cerebri. If, on the contrary, a semilunar flap be raised, it can simply be thrown back and requires no more holding; later on, the advantage of such a large flap, which can be laid down like the lid of a box, will be obvious, since, being continuous throughout, it offers plenty of resistance to the upward-pushing brain, which the point of meeting of four cross-cuts can never do; this indeed, on the contrary, favouring the very thing one wishes to avoid. The following details with reference to raising the flap will not be out of place here :—(1) All the parts superficial to the periosteum must be raised with the flap. (2) The curve must be a shallow arc, to avoid cutting collateral vessels. (3) It must be so drawn as not to divide the main arterial branches supplying that part of the scalp. The periosteum should be reflected by a crucial incision from an area corresponding to the first trephine-hole, and subsequently as more bone is cut away. The hæmorrhage from any large flap is very free; it is best met by cutting the flap boldly, compressing the incision as it is made with sterilised pads, and then catching the vessels, one by one, as the pads are lifted.

It is usually important to indicate on the bone itself, by the previous use of a small drill, the site of the first trephine-opening. Careful outlining of this on the shaven scalp will be of no avail after the flap has been lifted away. Measuring instruments have to be used again, perhaps without disinfection.

Removal of the Bone.—The cranial opening should always be sufficiently free. A cramped opening is certain to defeat the object of the operation in the case of a growth. Where exploration has to be made, an efficient and rapid way is to make a couple, or more, of trephine-holes at the opposite extremities of the area to be removed, then to cut half through the sides of such an area with a Gigli's saw, and, finally, to complete the division with a powerful bone-forceps (Fig. 114), or the intervening bone may be divided with the forceps of De Vilbiss or Keen.* Braatz (*Cent. f. Chir.*, 1898, No. 37) discusses at length the various means for trephining and raising large bone-flaps. He believes the use of Gigli's saw to be the best. This is passed between the dura mater and the bone through small trephine-openings which are placed at convenient intervals in the line of the flap to be removed. Another method, in which an ordinary saw is employed, has been mentioned at p. 284. It is obviously only to be used by experts with special experience in this branch of surgery. Operations on the brain, whatever means is employed of removing the skull, will be conducted in two stages (p. 295). Whatever instrument is used to divide the bone after the trephining, a copper spatula, or one of Horsley's spatulas (Fig. 116), should be introduced at the opening to separate the dura mater freely, and to protect this as the saw or forceps are used. Where it is possible to preserve the dura mater intact, the portions of bone removed should be preserved in hot sterilised saline solution, and, at the end of the operation, placed between the skin and dura mater,[*] if the case be one justifying this step (p. 206).

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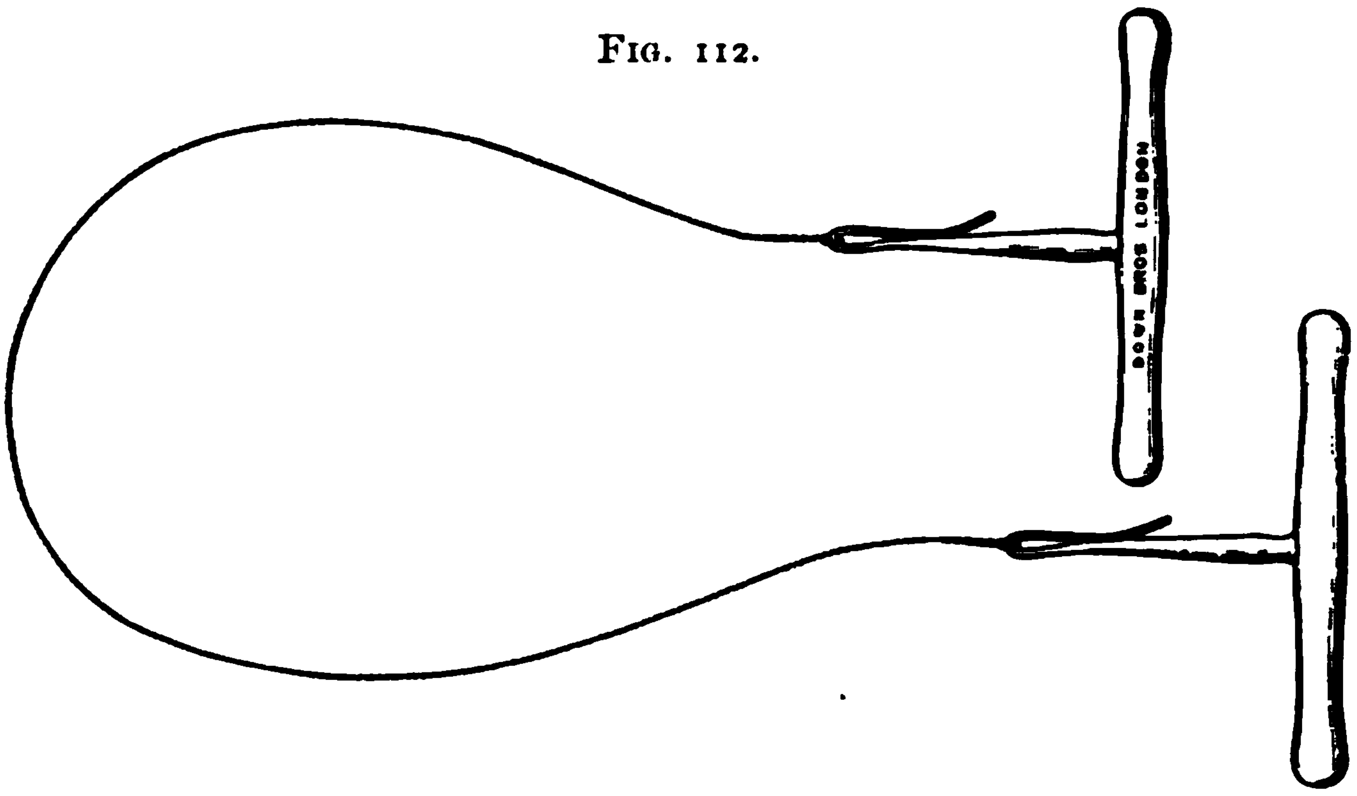
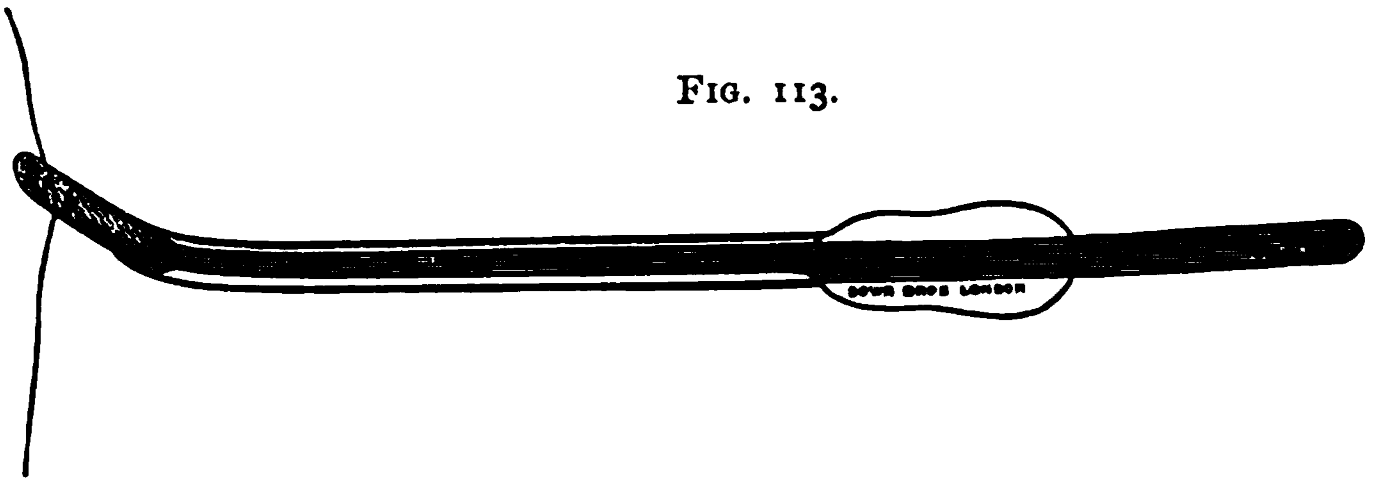
* A trephine worked by an electric motor or surgical engine requires much skill and care in maintaining the dura mater uninjured. I strongly advise practice and familiarity with a full-sized trephine, a good Hey's saw, *e.g.*, Mr. Horsley's modification of this instrument, and the cutting-forceps of De Vilbiss (Fig. 115). These last are not so well known in England as they deserve to be: I owe my acquaintance with them to that most courteous and modest of Americans, Dr. Rixford, of San Francisco. Those who wish to be familiar with the modes of removing part of the cranium by trephines and saws, worked with different motors, will find the needful information in articles by Dr. S. D. Powell, of New York (*Med. Ann.*, 1899, p. 513), and Dursdale, of New York (in the *New York Policlinic*, July 15, 1897), and Down Bros.' *Cat.*, 1900, p. 115. See also the remarks, p [illegible] is book.

FIG. 112.



Gigli's thread-saw. (Down Bros. Cat.)

FIG. 113.



Steel director and whalebone guide for use with Gigli's saw.

Holes are first made with a small trephine, then the director makes a way for the whalebone guide, threaded with silk. The guide is withdrawn, leaving the silk *in situ;* the silk afterwards assists in the passage of the Gigli's saw. (Down Bros.' Cat.)

When the bone removed is only of moderate size, *e.g.*, that of an ordinary trephine crown, it may be replaced in one piece, especially in young subjects; the vitality of older bone is better secured by subdividing it (Macewen). Where a large area of the brain has been exposed, it will be well, in order to preserve the contour of the skull, to replace the whole piece. To provide drainage and prevent necrosis, such large piece should have been deeply notched, or freely punched or drilled with holes, so that a lattice-work and not solid bone is left. Such steps, however, seriously impair the vitality of the bone and often lead to its eventually not surviving. No time should ever be wasted at the close of a severe operation in replacing the bone.

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[*] Though the vitality of the fragments has invariably been perfectly preserved, Mr. Horsley has not, so far, observed much ossification of the cicatrix. Where a large area of bone has been removed, a perforated celluloid cap, light, but very strong, is recommended.

Further observations, continued over a sufficient time, are needed before we can estimate the real value of bone reimplanted after trephining. In cases where a safety-valve is needed, as in traumatic epilepsy, I consider it to be a mistake to put back the bone, whether in the form of crowns or divided into fragments. The former will prevent any safety-valve being left, which is so essential for the varying and excitable circulation beneath. The latter—reimplantation of the fragments after they have been divided—is likely to be followed by their atrophy and absorption, and in some cases by their leading to irritation and thickening of the dura mater (Mr. Mansell Moullin, *Brit. Med. Journ.*, vol. i. 1898, p. 427).

The method of removing a large flap of soft parts and bone, by cutting through it with a chisel, which has found favour in Germany (Wagner) and America (Hartley, McBurney), is condemned by Mr. Horsley as harmful and inexpedient: harmful because hammering the skull must increase the shock, and inexpedient inasmuch as the pericranium has no osteogenetic power, and, therefore, it is a matter of no moment whether it be retained in contact with the bone or no.

Operation in Two Stages.—To avoid shock, so fatal in these cases, the above course has been advised by Mr. Horsley and Macewen. The latter has adopted it for five years, and has recorded (*loc. supra cit.*) three striking cases in proof of its value. This step, in which the skull is first sufficiently opened, and at the second stage, some days later, the growth removed, if possible, not only diminishes shock, but also, by soldering the membranes at the margin of the exposed brain, shuts off the sub-dural space, and so prevents the escape of blood into it.

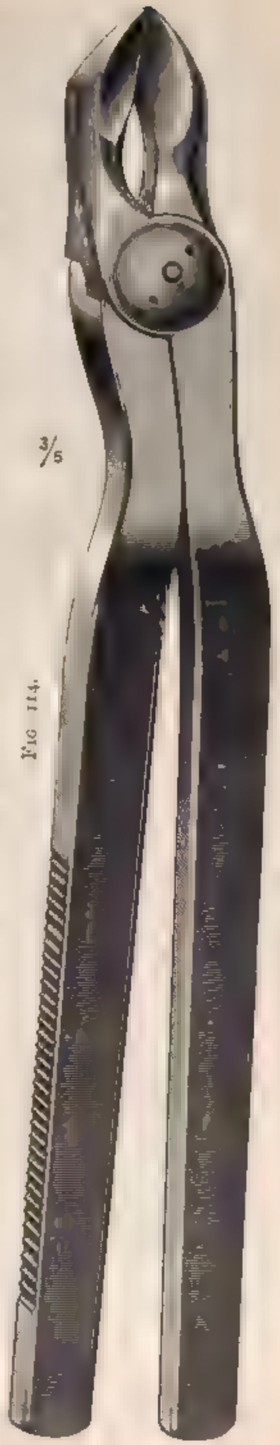
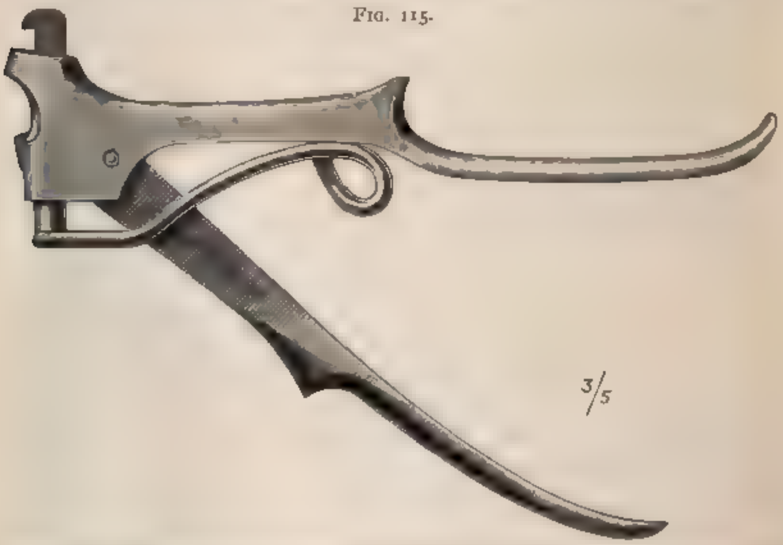


Fig 114.

Powerful bone-forceps, used by Mr Horsley in the division of the skull. They are made by Hawksley

Treatment of the Dura Mater.—This should be incised round four-fifths of the circumference of the area exposed, at $\frac{1}{8}$ inch distance from the edge of the bone, so as to render it possible to stitch the edges together afterwards. The dura mater is best opened first by incision with a scalpel or sharp-pointed bistoury, and then by blunt-pointed curved scissors, great care being taken not to wound the parts beneath: tenaculum-forceps will be found useful here. The main branches of the middle meningeal are best secured by underrunning before they are divided. The dura mater should be raised with much gentleness, as if any adhesions are torn, very free venous hæmorrhage may result (p. 227)

Fig. 115.



Forceps of De Vilbiss, especially adapted for the division of the bones of the cranial vault.

Treatment of the Brain.[*] If this, after incision of the dura mater, bulges very prominently into the wound, it indicates pathological intracranial tension, and probably a tumour.[†] Alterations in the density of the brain must next be observed, but it must be remembered that cerebral tumours situated beneath the cortex are scarcely to be detected, save by exploratory incision. Dr. Weir (*loc. supra cit.*) thinks a needle of very little value in exploration of a growth. A tumour too soft to be detected by the finger will not be recognised by the needle. Furthermore, two cases have come to Prof. Keen's knowledge in which fatal hæmorrhage followed its use. Careful palpation and the insinuation of the finger-tip under the trephine-opening are preferable. Prof. Keen (*loc. supra cit.*) points out that the brain allows of gentle pressure very readily, and that the finger can be inserted, for the purpose of examination, an inch all round the opening.

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[*] Any of the dura mater which is adherent to the tumour is usually much altered. If the mischief is recent, the membrane will be simply highly vascular. In advanced cases it may be yellowish, and in some instances, on separating it from the growth beneath, it is found to be of a dirty reddish colour. In all cases where it is adherent the dura mater must be freely excised, if possible.

[†] In some cases where there is abundant evidence of intracranial tension a growth may be present, but out of the range of the operation Thus, in a case in which Dr. Weir (*Ann. of Surg*, June 1887) trephined over the upper part of the right fissure of Rolando for spasms in the left limbs and loss of power in the left leg, no growth was found. Death took place ten weeks later, and a spindle-celled sarcoma, apparently originating in the pia mater, was found springing from the lower surface of the left cerebellar lobe displacing the medulla forwards to the right, and invading the fourth ventricle. Dr. L S. Pilcher (*Ann of Surg.*, March 1889) relates the case of a man who presented symptoms which, though not very definite, were not inconsistent with the existence of a growth in the left angular gyrus, or its immediate vicinity, the site of a previous injury. Trephining being performed, the dura mater and brain projected so

Hæmorrhage.—In removing a portion of the brain, or a tumour, the bleeding which has been so much dreaded will usually cease if the wound be packed for a few minutes with strips of iodoform gauze wrung out of carbolic acid lotion (1 in 20). If it recur, the strips must be left in. The value of a preliminary injection of morphine has already been alluded to, and Mr. Horsley further points out that, owing to the fact of the main vessels remaining in the pia mater, they can be raised from the brain, and especially out of the sulci, so as to allow of the subjacent brain being removed. Other means of arresting hæmorrhage are boiling water, cooled to 105° or 110°; fine catgut ligatures tied without jerking, and not too tightly; or Mr. Ballance's method (p. 265). Mr. Horsley has invented a combination of fine dissector and small aneurysm-needle well adapted to facilitate underrunning and ligature of the vessels of the pia mater. If any bleeding vessel is not well within reach, the opening must be enlarged to get at it. When other methods fail, Spencer Wells's forceps may be left on for thirty-six or forty-eight hours; but the patient must be carefully watched, lest his restlessness cause the friable tissues to give way, or inflict damage on his brain. The treatment of hæmorrhage from the meningeal or diploic vessels, or any of the large venous sinuses, has been given at pp. 215, 229.

Incision of the Brain.—The cuts in the cortex must be made exactly vertical to the surface. If possible, portions of each centre should always be left, so that the representation of its movements may never be totally destroyed. A portion of brain removed does not leave, as might have been supposed, a permanent gap with vertical sides, for, in a very short time, the corona radiata forming the floor of the pit bulges almost to a level with the surrounding cortex.

Difficulty in Detecting the Growth.[*]—This may arise from several causes. (1) The want of distinctness in the growth—in other words, its close resemblance to brain substance.[†] (2) By the growth being overlaid by normal brain-substance (pp. 280-284). (3) By change in

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strongly that. after the former had been reflected, a rent took place in the cortical portion, ¼ inch deep. No growth was found, and the patient died thirty-eight hours later with pulmonary œdema. The necropsy showed an infiltrating glioma in "the anterior half of the left hemisphere."

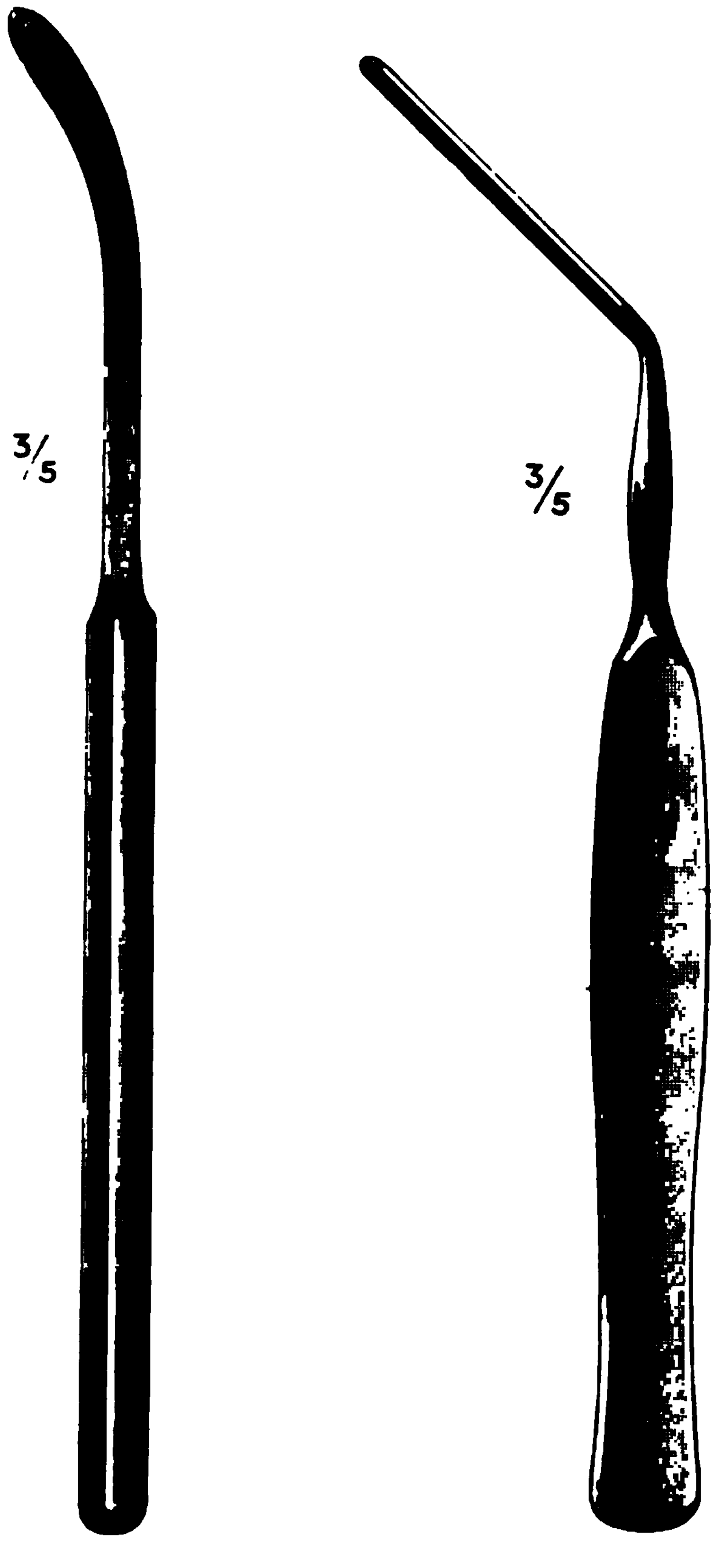
[*] I have confined myself here to gliomata, the commonest of cerebral tumours.

[†] "A glioma may be of a pinkish-red colour, or it may look so exactly like the normal brain substance that a microscope is required to demonstrate its presence."—Dr. Fagge, *Medicine*, vol. i. p. 523.

the growth—viz., hæmorrhage from its thin-walled vessels, and, later on, caseation of the coagula; these conditions being likely to puzzle the operator.

Difficulty in Isolating the Growth.—(1) This may be due to the absence of a capsule, and thus to the infiltration of the surrounding parts. Now that gliomata, owing to the operative attacks which will be made upon them, are of such practical importance from a new point of view, this question of a capsule is a very weighty one. It seems to be a disputed point. Thus, in Dr. Bennett and Mr. Godlee's case the glioma was found to be "thinly encapsuled, but quite isolated from the surrounding brain-substance." Not so, however, is it in many other cases. Indeed, the chief pathologists speak decisively on this point. Dr. Fagge (*loc. supra cit.*) wrote: The substance of glioma "is always continuous with that of the surrounding cerebral tissue, for there is

Fig. 116.



Combined blunt dissectors and spatulæ used by Mr. Horsley. They are equally adapted for the protection of the dura mater under the saw, or for the separation of a growth from the surrounding brain. They also act as flat probes in testing the depth of trephine-holes.

never a capsule * as with some sarcomata. Indeed, it often assumes the form of the part in which it grows, so that one might imagine the corpus striatum or the thalamus, or some particular convolution, to have become swollen to three or four times its usual size."

Dr. Ferrier (*Brit. Med. Journ.*, Oct. 1, 1898, p. 966) says on this point: "It is unfortunately the case that a large proportion of the tumours which invade the brain are of an infiltrating character, and apt to recur in spite of apparently the most complete extirpation. One can scarcely hope for a cure, therefore, under such conditions; but, nevertheless, there are many cases in which extirpation of such tumours has, for a time at least, rescued the patient from impending coma and death, and restored him for a time to clearness of intellect and a fair degree of comfort." A little later on we are advised that, "It is, on the whole, better not to attempt to remove a tumour which proves to be a soft infiltrating one without distinct demarcation from the healthy brain-substance."

(2) Another source of doubt in telling when a glioma not encapsulated has been isolated, arises from the fact that, as pointed out by Dr. Fagge (*loc. supra cit.*), these growths, in common with all the less circumscribed form of cerebral tumours, are apt to set up morbid changes in their immediate vicinity, usually of the nature of softening, partly inflammatory, partly œdematous.

If a cyst be found it should be completely removed if possible. If this be not feasible, all the more superficial part should be cut away, the interior wiped over with a stick of silver nitrate, and packed with iodoform gauze.

Excision of Cortex Centres for Epilepsy.—I have referred to this matter fully at pp. 223, 230. As this is an operation which may be repeated in the future, it will be well to mention one case in which Prof. Keen, of Philadelphia (*Amer. Journ. Med. Sci.*, Oct. and Nov. 1888), excised the centre for the left wrist and hand in an epileptic whose fits always began in the left hand. Marked success followed the operation; but the need of watching any case for a long period before a success is claimed has been fully explained at p. 230.

The patient, aged 20, had had a fall on his head when 13. There were no definite traces of this, and exploration of the part which had possibly been struck detected nothing abnormal. Each fit invariably began in the left arm and fingers. The thumb and fingers became rigid and extended, widely separated, the hand and forearm in a right line, and the elbow flexed. Usually both legs were then attacked, the left usually before the right, and crossed in front of it; next, the face, the mouth being drawn to the left. After this the convulsions became general.

The fissure of Rolando having been marked on the scalp; in order to indicate it on the skull itself, two small incisions were made at the ends of the line, and with a bone-gouge two small circles were made through those on the skull. A 1½-inch trephine was then applied with the centre-pin ⅛ inch behind the fissure of Rolando, the lower margin of the trephine being about ½ inch above the temporal ridge. The crown was placed in 1-2000 bichloride solution, carefully kept at T. 100°–105°. The bone and dura mater both appeared normal; no bulging was observed, and the pulsation was regular. The dura was now incised. The pia was very much infiltrated with serum, producing an œdematous layer much obscuring the brain tissue, especially the sulci over all this area. Two convolutions, running obliquely downwards and forwards, crossed the trephine opening, while at the interior border a third convolution, with, apparently, a like direction, came into view. An attempt was made to determine which was the Rolando fissure, by examining the depths of the sulci, but as both were about 1 inch deep, this gave no clue. By the cyrtometer (disinfected) the position of the fissure of Rolando was re-determined. This ran in the middle of the three convolutions. To determine the seat of the hand-centre a faradaic battery was used, the ends of the wires being wrapped in borated cotton dipped in bichloride solution. Stimulating the two posterior convolutions gave no results. When the anterior one of the three was touched the hand instantly moved, the wrist and fingers being extended. Above this centre were the shoulder and elbow centres, and below, that for the face. The opening in the skull was now enlarged, and the portion of the hand-centre about 1¼ inch long, as ascertained by the battery, was then incised above and below with a knife, the lower incision being ⅜ inch above the temporal ridge. The lower end of the portion to be removed was then lifted up, and the loosened convolution cut away with scissors. While this was done, no movement was perceived. The battery wires were now again applied. At the remaining part of the convolution above, flexure and extension of the left elbow, elevation and abduction of the shoulder, were noticed. Touching the part remaining below produced an upward movement of the whole left face. The large vessels in the brain were extremely gently tied with chromic gut, and oozing checked by hot water and cocaine (4 per cent.). The dura mater was sewn with chromic gut, two bundles of horsehair being placed beneath it. The disc of bone and some fifteen pieces removed were replaced on the dura. Soon after the patient recovered from the ether he had a fit, but the hand did not move. The patient made a good recovery, and a month after the operation the skull was as firm on one side as the other, with very slight, if any, irregularity where the pieces of bone were replaced. The fits were greatly diminished, and only of a momentary character, practically *petit mal*. There was no convulsive movement whatever; the hands and wrist were as before. Seven weeks after the operation the patient wrote that motion was returning in the left hand. Dr. Keen thought that by "compensation" it was nearly certain that in time control over the left hand would be regained through the other hand-centre.

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* The glioma "is distinguished by having no capsule, but merging indefinitely into the tissue around. It is firm and tough, otherwise very like brain tissue, but more pellucid."—Dr. Wilks and Dr. Moxon, *Path. Anat.*, p. 239.

The above remarks refer to attempts to remove certain definitely localised small centres. The following words of Prof. Macewen (*Brit. Med. Journ.*, Aug. 11, 1888) have an important bearing on this matter, and, from his wide experience, carry great weight:—"Can the motor area be removed in large pieces with immunity from serious consequences? If this region be of such psychical importance to movement, and destructive cortical lesions in it are followed by secondary degeneration of the motor tracts, then excision of these areas will necessarily induce permanent paralysis, late rigidity, and ultimate structural contracture. The removal of large wedges from the brain, especially in the motor centres, will produce serious effects upon the brain as a whole, causing, during cicatrisation, a dragging and displacement of the neighbouring parts, with final anchoring of the cerebrum to the cicatrix.* . . . In the presence of a stationary cicatrix, or a slow-growing neoplasm in the motor area, occasionally producing fits, few would attempt the removal of such a large wedge of the motor region as to induce permanent hemiplegia. Even when the fits are much more numerous and aggravated, it is serious to contemplate the production of hemiplegia while attempting the cure of the fits. No doubt these epilepsies, when long continued, especially in early life, are apt to lead to great and extensive instability of the motor cortex, so as to warp the whole cerebral function, and ultimately involve life itself. Still, how much better is the cure by the removal of a large wedge, involving the greater part of the motor area? How many people would submit to have their upper and lower limbs on the same side of the body amputated at their proximal points—for this is what the hemiplegia amounts to—in the process of cure of their fits? Numerous epileptics have been asked the question by me, but none have expressed their willingness to undergo such a cure. Even had they done so, the circumstances would require to have been exceptional to induce one to hazard the life of the patient for so poor a result. . . . . . Nor is the removal of very large tumours and large wedges of brain free from immediate peril to life. In several instances operated on elsewhere death has ensued—one while the tumour was being removed, and one immediately after the completion of the operation."

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* "*Anchoring of the Brain, and some of its Consequences.*—When injury has been inflicted on the surface of the cerebrum, followed by plastic effusion and cicatricial formation, the superficial substance is apt to become soldered to the membranes when these remain intact, which in turn may be soldered to the skull, or, in the event of their detachment, the brain may become directly adherent to the bone. Thus, the surface of the brain becomes anchored or soldered to its rigid walls. It has no longer the free play within its water-bed to expand and contract according to the varying states of the circulation. Each variation produces a dragging of the brain at the spot, and through it the whole hemisphere at least is affected. Any sudden physical effort pulls on the

Closure of the Wound.—All bleeding having stopped, the cut dura mater is sutured with fine catgut, and the pieces of bone are placed on it. If the brain bulges much when the dura mater is being sutured, it should be depressed with a copper spatula, while the edges of the dura are quickly sutured by a continuous catgut suture. Room must be left for drainage, and the flap secured with salmon-gut and horsehair sutures. Mr. Horsley removes the drainage-tube, which is to be inserted at the most dependent part of the incision (as the patient lies in bed), at the end of twenty-four hours, and makes firm but gentle pressure over the centre of the flap. The tube serves to remove the steady oozing of blood and serum from the cut surfaces, which takes place during the first twenty-four hours, and its removal at the end of this time is advised, in order to allow of a certain amount of tension from wound exudation to occur within the cavity; this tension not interfering with primary union if kept within proper bounds, while it secures pressure on the brain which is tending to extrude, and serves, when the wound is finally healed, to separate the skin-flap from the brain beneath by a cushion of soft connective tissue. If, after the removal of the tube, there is much pain and throbbing in the wound, and the union threatens

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brain, producing a slight shock, a momentary disturbance just as if the cerebrum had received a blow. Vertigo results. People affected in this way cannot rise up quickly, or perform any sudden movement of the body or head, without experiencing a sensation of giddiness, which sometimes causes them to drop. Following upon this, the grey matter of the cortex, immediately surrounding the cicatrix, by the incessant movement is apt to become unstable and produce fits. Some cases of traumatic epilepsy are thus caused. Further, if the cortical irritation be continued, encephalitis is occasionally produced, often appearing in a chronic form and long remaining so, though susceptible of being lit up into an acute affection. If the temperature remain high, active interference is apt to induce an extension of the encephalitis. Operation in such cases should be, when possible, postponed. The disregard of this advice has, to my knowledge, in one instance hastened the fatal issue, encephalitis becoming rapidly general."

to break down, the edges must be sufficiently separated with a probe, gently used, in the track of the drainage-tube.

Causes of difficulty in cerebral operations and of their not doing well:

1. The anæsthetic not being well taken (p. 304).
2. Hæmorrhage (p. 309). In two cases the hæmorrhage has occurred some little time after the operation, and has been due to the vomiting after the anæsthetic.
3. Shock.
4. Œdema of the lungs. This is especially likely after prolonged operations, where it has been needful to give ether, and in cases where, for some time before the operation, the patient has been practically bedridden, and the functions at a very low ebb.
5. Hernia cerebri. This may occur in two ways: (*a*) Immediately, during the operation, in a case where there is much evidence of intracranial pressure, and where it has not been possible to remove the cause. Thus, in a case of Dr. Pilcher's (*loc. supra cit.*), the projecting cerebral mass was so great in volume and so tense that there was no possibility of returning it within the cranial cavity or of covering it by the usual flaps. Accordingly it was sliced down to the level of the bone. (*b*) Later on, it may point to unrelieved tension, as in a case of mine of cerebral abscess to which I have alluded (p. 256), and in which a good recovery took place after evacuation of the re-collection of pus. In such a case constant pressure with the aid of a piece of sheet-lead, notched or perforated for the drainage-tube, will be found most useful. In other and more numerous cases a later hernia cerebri indicates septic changes. Dr. Macewen thus points out another cause: "It is true that round many neoplasms there is a zone of encephalitis, and, should this be extensive and of the nature of red softening, false hernia cerebri is prone to form. It was supposed that false hernia cerebri was entirely due to decomposition, many recent writers averring that it cannot occur unless when operations are conducted non-antiseptically, basing their belief on experimental investigations conducted on brains in a physiological state. Had they concluded that the formation of false hernia cerebri, after operations, was principally caused by decomposition, and always so when it occurred after operations on a physiological cerebrum, they would have been right. The consistence of false hernia cerebri is identical with red softening of the brain occurring in idiopathic affections in which there had been no operation. In one instance, in which trephining was performed for the relief of pressure causing total hemiplegia, and where the symptoms indicated either acute encephalitis or abscess, or both, the moment the dura mater was opened a large mass of encephalitis protruded through the membranes, forming a false hernia cerebri on the surface of the scalp. This encephalitis was not occasioned by septic matter introduced through a wound, as it occurred the moment the wound was made. Around neoplasms red softening sometimes exists, and interference might possibly occasion an extension of the affection, though were the operation conducted with strict antiseptic precautions the possibility of its formation would be reduced to a minimum. With this exception, there has been no false hernia cerebri after any of my operations."
6. Septicæmia.

7. Impossibility of complete removal.
8. Recurrence.

In some cases where the growth has not been found, or where its complete removal has not been possible, the symptoms have been materially improved by the relief given to the pressure. Thus, in the *Lancet* of April 7, 1888, a case under the care of Mr. F. A. Heath is reported, in which, though the tumour was not removed, owing to adhesions to the anterior fossa, the benefit derived from the relief given to the pressure was most decided.

The patient recovered promptly from the operation, with the formation of a hernia under the healed scalp, shortly after regained a considerable power of motion in the paretic limbs, remained free from epileptic attacks for over two months, and for a long time was rid of the headache. He was seen thirteen months after the operation, and, though completely blind, could walk about very well. Of late the headache had returned and the epileptic attacks had become more frequent.

The following case of Fischer's, of Breslau (*Centr. f. Chir.*, Bd. xxix. 1889), bears on the same point.

A patient was admitted with complete paralysis of the right arm, which had been coming on for a year, and very severe headache on the left side. The right leg was also weaker, dragging a little in walking. The left pre-central convolution was exposed, but no trace of a tumour could be found. The patient experienced great relief from the operation. The headache was gone, the arm-paralysis was less, and the convulsions ceased. Five months later the patient began to complain again, the paralysis of the right arm and leg having increased, and epileptiform seizures being of daily occurrence. He urged repetition of the operation. The skull being again opened at the same place, a red lobulated tumour soon bulged up. It was shelled out piecemeal with the finger, as it continually broke off on pulling, severe hæmorrhage resulting. The growth was also firmly adherent to the dura. The hole in the brain was lightly plugged with iodoform gauze. All symptoms of growth were again in abeyance. Two months later the patient began to complain again, and now a growth grew through the trephine opening. The necropsy showed that the growth of the brain had been completely removed. The recurrence started from the dura. It was a vascular round-celled sarcoma.

This occurrence of improvement in the symptoms, due to relief given to the intracranial tension, has been also referred to at pp. 292, 293, 295.

CHAPTER IV.

OPERATIONS ON THE FACE.

OPERATIONS ON THE FIFTH NERVE.

As the surgeon will not be called in until all other treatment has failed and the patient is desirous of relief as radical as may be, neurectomy alone will be described here.

With regard to the two operations, neurectomy and nerve-stretching, I think their respective value may be summed up in some such way as this. It would appear from Wagner's* laborious collection of 135 cases of neurectomy, that 18 remained cured after as long a period as three years. I am unable to find any case of nerve-stretching reported as cured after a longer period of watching than eight months.†

First Division of Fifth Nerve: Neurectomy.

Neurectomy. The incision should be horizontal, and lie below the margin of the eyebrow, thus leaving little scar. The supra-orbital notch being made out‡ by firm pressure when the patient is under an anæsthetic, the eyebrow is drawn up and the eyelid down, and an incision 1½ inch long is made along the supra-orbital margin, with its centre opposite to the notch. The skin, occipito-frontalis, orbicularis, and palpebral ligament being divided, the cellular tissue is separated, the nerve found in the notch, set free, traced back as far as possible so as to include the supra-trochlear if that be feasible, drawn up with a strabismus hook, and a full inch removed. The wound should be closed with a few horsehair sutures.

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* *Arch. f. Chir.*, Bd. xi.

† For a reference to the statistics of Hahn, of Berlin, quoted by Dr. Chandler in his tabulation of cases (*New York Med. Record*), and for Dr. Gray's tables (*Journ. of Neurology and Psychiatry*, May 1882), I am indebted to a paper by Dr. G. R. Fowler (*Annals of Surgery*, vol. iii. No. 4, p. 209), which for its fulness and impartiality is well worthy of reference. For the more detailed and recent account of these and all operations on nerves, I would refer my readers to M. Chipault's *Chir. opér. du Syst. Nerveux*, tt. i. et ii., Paris 1895.

‡ "The supra-orbital notch or foramen occupies about the junction of the inner with the middle third of the supra-orbital margin. From this point a perpendicular line, drawn with a slight inclination outwards, so as to cross the interval between the two bicuspid teeth in both jaws, passes over the infra-orbital and the mental foramina. The direction of these two lower foramina looks towards the angle of the nose."—Mr. Holden, *Landmarks Medical and Surgical*, p. 6.

[illegible]

[illegible] Pterygo-maxillary [illegible]

1873 [illegible]

the [illegible]

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* In a patient of Dr. [illegible] attempt to receive food [illegible] pain of the most frightful character [illegible] having a funnel passed back to the pharynx [illegible] diseased side, that he was enabled to take food at all and that [illegible]

† Dr. Maclean, of Detroit, in a discussion on [illegible] Dental Nerve, by Dr. Mears" (*Trans.* [illegible]) two cases of men, aged 72 and [illegible], in the first of whom he [illegible] inferior dental, and in the second the supra- and infra-orbital [illegible] good result having lasted six years in the first case.

but at the side, by an operation which turns down the zygoma and masseter, and is similar to that described as Rose's (p. 322). The advantages claimed are that the antrum is not opened, an objection to which I have alluded above. Again, the scar, being placed at the side, is less prominent when the patient is looked at full-face. In reply to this, I would say that in the only case (p. 324) in which I have performed Carnochan's operation, the scar was subsequently very little noticeable. As I look upon the pterygo-maxillary operation as graver than Carnochan's, more troublesome from bleeding, more risky of grave septic results from its relations (*e.g.*, the pterygoid plexus), and more certain to be followed by stiffness of the jaw, I should only perform it in cases where it was probable that the third division should be resected at the foramen ovale, as well as the second in the spheno-maxillary fossa or at the foramen rotundum.

Antral Operation.—This, often known as Carnochan's, has the advantage of removing the whole of the second division of the fifth, together with the spheno-palatine ganglion as far back as the foramen rotundum, the nerve forming the guide to the surgeon from the surface backwards.

Carnochan (*Amer. Journ. Med. Sci.*, 1858, p. 136) looked upon the removal of Meckel's ganglion as the key of the operation. Whether or no his view was right, that this body could be likened to a galvanic battery, keeping up a continuous supply of "morbid nervous sensibility," there is no doubt that removal of the nerve *beyond* the ganglion is strongly advisable, as by this step the spheno-palatine branches to the gums are also removed. As pointed out by Mr. Chavasse (*Med.-Chir. Trans.*, vol. lxvii. p. 151) and Mr. Clutton (*St. Thomas's Hosp. Rep.*, vol. xv. p. 213), removal of the nerve *beyond* Meckel's ganglion ensures the disconnection of the posterior dental nerve* from the brain, which is probably the explanation of the success which follows the operation.

An anæsthetic having been given, and the parts shaved† and cleansed, a T-incision is made with the horizontal portion reaching from canthus to canthus just below the orbit, and the vertical one running down close to the angle of the mouth. The flaps thus marked out being reflected and all hæmorrhage stopped, the infra-orbital nerve is defined, cut as long as possible, and a piece of silk tied round it to make it serve as a guide.

A ½-inch trephine is then applied just below, and including, the infra-orbital foramen, so as to remove the anterior wall of the antrum; next, the same sized or a ¼-inch trephine is applied to the posterior wall of this cavity so as to expose the spheno-maxillary fossa. Free and troublesome hæmorrhage must be expected, partly from the vascular facial bone,‡ partly from the mucous membrane of the antrum, and in the fossa itself, where the bleeding is always copious, from the terminal branches of the internal maxillary. Pressure with small gauze pledgets in holders may be relied upon. The next step is to open up the infra-orbital canal with a small chisel; strong scissors or fine cutting-pliers being used to enlarge the wound.

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* In both of Mr. Chavasse's cases the commencement of the pain was invariably referred to the periphery of the posterior dental branches, and it appeared very doubtful if stretching would have had any effect on slender branches at some distance from the extension point. Both of these cases remained practically well two years and a year and a half respectively after the operation.

† In one of Mr. Clutton's cases this could not have been borne before. Recurrence, slight and relieved by quinine, ensued in both of Mr. Clutton's cases within the year.

‡ The superficial hæmorrhage will be all the freer in proportion as the part has been recently submitted to blistering, liniments, &c.

During the operation, if daylight fail, a laryngeal mirror and artificial (or electric) light will greatly help the surgeon.

The nerve being now brought into the posterior trephine-aperture, it is traced into the spheno-maxillary fossa, which it enters through the foramen rotundum. Being kept on the stretch by means of the piece of silk, it is severed with long, delicate, curved scissors as far back and as near the foramen as possible. If it is still held by filaments passing downwards (spheno-palatine branches), these should be also divided with scissors. Mr. Clutton considers that the total length of nerve removed from the infra-orbital foramen to the foramen rotundum should be at least 1¾ inch, without including any of its branches. Sterilised iodoform should be dusted in at once, and the wound plugged temporarily with strips of sterilised iodoform gauze. When all hæmorrhage has stopped, these are removed, and the spheno-maxillary fossa and antrum are lightly plugged with the same material. The flaps are partially adjusted with a few points of suture, leaving room for drainage and the removal of the strips.*

Difficulties which may be met with during the Operation.—1. Hæmorrhage. 2. The nerve breaking, or being divided prematurely. 3. A deep wound, difficult to illuminate, especially if the antrum is deep between the two trephine wounds.

After any of these operations on the fifth nerve the patient should be strictly cautioned to avoid exposure to any of the causes of a return of his enemy. The chief are given below (p. 331).

Operations on the Third Division of the Fifth Nerve.—I shall describe here neurectomy, first of the inferior dental, a nerve so commonly the seat of neuralgia; then of the lingual gustatory, which is much less frequently affected; and, lastly, operations by which the trunk can be reached at the foramen ovale, part of the Gasserian ganglion removed, and the second division attacked at the same time.

Inferior Dental: Neurectomy.—This nerve may be attacked in three places—at the mental foramen, in the dental canal, and above the dental canal. Experience has shown that the relief after the first two methods is so transitory that the higher operation should always be resorted to. The best method is that by which the nerve is reached through widening the sigmoid notch. This is practically an old operation of Velpeau's, much improved and modified according to the needs of modern surgery by Mr. Horsley (*Brit. Med. Journ.*, vol. ii. 1891, p. 119) and Mr. Rose (*ibid.*, vol. i. 1892, p. 160). The face having been shaved and cleansed, the external meatus cleansed and plugged with aseptic wool, the patient is placed under an anæsthetic, and an incision is made, starting from about the middle of the zygoma, passing backwards and downwards in front of the tragus to the angle of the jaw, and then forwards as far as a spot just behind the facial artery. The flap, consisting of skin and superficial fascia only, is raised forwards as far as the anterior border of the masseter, and the edge of the parotid and the lower border of Stenson's duct are then clearly defined. The greatest care must be taken during the above step not to divide any of the branches of the facial nerve or to injure any of the lobules of the parotid gland. The flap having been turned forward and covered by sterilised gauze, the masseteric fascia and muscle are divided down to the bone horizontally between Stenson's duct and the highest branch of the facial nerve below it. The muscle and periosteum are then separated by blunt raspatories with sufficient freedom to expose the sigmoid notch and the adjacent parts of the coronoid and condyloid process. Smart oozing must be expected from the masseteric artery, and arrested by firmly applied sponge-pressure. The next step consists in enlarging the sigmoid notch as far as the upper orifice of the dental canal. This is done by applying a ¾-inch trephine in such a way as to leave between it and the notch a narrow bridge of bone, subsequently clipped away with bone-forceps. Great care must be taken, owing to the varying thickness of the bone, in the use of the trephine; otherwise the inferior dental artery will be wounded or the bone fractured.[*] De Vilbiss's forceps (p. 308) will very likely be useful here. The bone having been removed sufficiently, some loose yellow fat usually comes into view, and, to avoid bleeding, the inferior dental and the internal maxillary, if this be in the way, should be secured between two ligatures. The inferior dental nerve is next identified and secured by a silk ligature. The external pterygoid having been levered upwards, or divided if needful, the nerve is followed close up to the foramen ovale, and divided as high up and as low down as possible. The lingual nerve, which lies somewhat anteriorly and on a deeper plane, is then treated in a similar way. Any venous bleeding which cannot be dealt with by ligature should be met by firm pressure with aseptic gauze. The wound, carefully kept aseptic throughout, is now thoroughly dried, a small drainage-tube inserted if there be still much oozing or if the parts have been much disturbed, and the wound accurately united with horsehair sutures.

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* To be removed in twenty-four or forty-eight hours, according to the amount of hæmorrhage met with during the operation.

Lingual Gustatory: Neurectomy within the Mouth.—In a few cases of epithelioma of the tongue, not admitting of removal, this operation may be performed in the hope of relieving the pain, and diminishing the rapidity of the growth, the profuseness of the fœtid dribbling saliva, &c. In another small group of cases, neuralgia of the tongue, resisting other treatment, this operation may be resorted to with entire success.

The best method is that of Roser, of Marburg, who introduced it in 1855, though it is known in France as the operation of Létiévant (Chabot, *Chirurg. opérat.*, p. 134). The mouth having been widely opened in a good light, and the tongue drawn over to the opposite side, an incision is made in the fold of mucous membrane between the side of the tongue and the gum, the centre of the incision being opposite to the last molar tooth. The overlying mucous membrane is here so thin that the nerve can usually be seen below it. The nerve having been exposed where it lies beneath mucous membrane only, just before it dips beneath the myo-hyoid, is raised with an aneurysm-needle, and a full inch removed. The only after-treatment required is the frequent use of a mouth-wash.

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[*] To avoid this last complication Mr. Horsley advises first drilling the bone with a row of holes along the line of the part to be removed, and then cutting it out with curved bone-forceps (*loc. supra cit.*, p. 1193, Fig. 2).

I have performed this operation on two occasions. In one the patient remained absolutely free from her neuralgia for twelve months, after which there was some recurrence owing to her entire neglect to avail herself of the fresh air and rest which were so necessary in this case. The second patient was operated on only three months ago, an interval much too short to allow of drawing a conclusion.

Removal, more or less complete, of the Gasserian Ganglion.—Neurectomy of the Third and Second Divisions of the Fifth Nerve in front of the Ganglion.—Division of the Sensory Root of the Fifth Nerve.

These operations are justified by the fact that, as a rule, neuralgia returns within a period of nine months to two years after neurectomy of the trunks and branches of the fifth nerve by any other operative steps.

How far these much graver operations will produce complete cures must at present be uncertain, as in several of the reported cases the history is only carried up to a few months after the operation. Accounts brought up to date of the cases which were earliest reported are much needed. It remains to add that the results of the chief operators, while warning us as to the high mortality which still accompanies the operation (*infra*, p. 328), are encouraging on the subject of recurrence. Thus, Prof. Keen, of Philadelphia, who has operated by the intracranial method in fourteen cases (*On Resection of the Gasserian Ganglion, with a Pathological Report on the Ganglia by Prof. Spiller*, 1898), writes: "What has been the history of the cases as to cure? So far as I know, there have been only four cases in which the pain has returned; one reported by Rose, one by Dana, and two by myself. But I especially desire to call attention to the fact that my own two cases of recurrence were my first two operations; that in Case I. no microscopical examination of the fragments was made, and in Case II. the examination revealed no ganglionic cells or nerve-fibres. Case I., as I now look at it, was imperfectly done, and Case II. still more so. Therefore the recurrence of pain in these two cases cannot be used as an argument against the removal of the ganglion. In addition to the above, Krause has reported one case in which the sensory root was found diseased, and the pain returned on the other side of the face. We can conclude, therefore, in general, as the result of experience in over 100 cases of intracranial operation, that, practically, the pain will not return in over 1 or 2 per cent. in any such severity as to liken it to the original disease, and that it will not return at all in more than 4 or 5 per cent." Dr. Tiffany, of Baltimore, who has afforded much help to surgeons in this matter by his article with a collection of 108 cases (*Trans. Amer. Surg. Assoc.*, 1896, p. 1), shows that while recurrence of pain may follow intracranial excision of branches of the fifth nerve close to the ganglion, recurrence has not been observed in those cases in which the ganglion itself has been known to be removed. "The place where the ganglion was supposed to be by the operator has been curetted, or pieces of tissue picked away with pincers, more or less in the dark: this does not constitute known removal; it does constitute attempted removal—a very different thing."

The above operative steps can be here described under the following heads:—

A. **Extracranial Method.**—By this the ganglion and the second and third branches are reached by trephining at the base of the skull from without. This method has been brought into prominence in this country by Mr. W. Rose, whose name it bears.

B. **Intracranial Method.**—Here the ganglion and the nerve trunks are got at within the middle fossa, the attack being made through the side of the skull (Horsley, Krause, Hartley).

A. **Extracranial Method: Rose's Operation.***—Stage i. *Reflection of Skin Flap.*—The operative area and the external meatus are first carefully sterilised (p. 304), and the eyelids secured in apposition by horsehair sutures, the precaution given at p. 327 being taken here also. The incision through the skin and superficial fascia only is made from a point near the outer canthus, about half an inch below the external angular process of the frontal bone, backwards along the upper border of the zygoma to its posterior extremity, then downwards just in front of the ear to the angle of the jaw, and finally forwards along the horizontal ramus as far as the facial vessels. The semicircular skin flap is raised without any damage to the facial nerve or Stenson's duct, and is carefully protected with a gauze dressing from any drops of the anæsthetic or other contamination. Stage ii. *Exposure of the Pterygoid Space.*—An incision having been made along the whole length of the zygoma, the periosteum is carefully detached. Two holes are then drilled through the root of the zygoma,† and two anteriorly through the zygomatic process of the malar bone. These are to admit of subsequent wiring of the bone, and so to ensure union without necrosis. The bone is then divided between them, posteriorly as near the root of the zygoma as possible, anteriorly in a direction obliquely downwards and forwards. The zygoma is then displaced downwards and backwards together with the masseter, this step being facilitated by the division of the muscular fibres attached anteriorly to the malar bone. Some loose cellular tissue being next removed, the coronoid process and temporal tendon are exposed, and the former process is divided obliquely downwards and forwards as low down as possible. It is then turned upwards and, with the tendon, cut away, as, owing to the subsequent wasting of the muscles of mastication, there is no object in leaving it, and every additional atom of space will be found most helpful in a wound-area so small and so crowded with important structures. Stage iii. *Exposure of the Foramen Ovale.*—It is here that the real difficulties of what is one of the most complicated operations in surgery commence. Removal of a little cellular fatty tissue will expose the external pterygoid and, probably, the internal maxillary artery lying upon it. This vessel having been divided and removed between two ligatures, the inferior dental and lingual gustatory should next be identified (if not divided at a previous operation) at the lower border of the muscle and secured with silk ligatures as guides. I may here remind my younger readers that these nerve trunks are much softer and look smaller in life than they do in the dissected subject. In order to expose the foramen, the muscle is removed partly by picking it away piecemeal with forceps, partly by scraping with curettes. By this means the under surface of the great wing of the sphenoid and the external pterygoid plate are exposed. The foramen ovale is now to be brought into view—a matter often of great difficulty, and occasional reference to a skull held by an assistant will be a considerable help in indicating its position to the surrounding structures. Its relation—usually a little behind and external—to the root of the external pterygoid plate is one of the best guides, but this is not quite constant. Following up the nerves by means of the silk ligature is, after all, the only reliable guide to the foramen, and to placing a probe in it. The chief difficulties here are (1) the very contracted space in which the operator has to work very deeply, with important structures hampering him by their closeness—*e.g.*, the foramen spinosum and middle meningeal artery, and the Eustachian tube, which lie just internal and posterior to the foramen. The operator should keep scrupulously in front[*] of the foramen. (2) The bleeding. In my case alluded to below, the venous oozing met with as soon as the pterygoid space was opened up was constant and baffling. It came not only from the pterygoid venous plexus, but from small veins passing through what proved later to be the foramen ovale, and communicating between the above plexus and the cavernous sinus, and also from others unnamed perforating the base of the skull. This oozing, which quickly flooded the small space which is all one has to work in, was arrested by firm sponge-pressure, but as soon as the work of picking away the external pterygoid so as to define the base of the skull was resumed, it started afresh, and this necessitated the administration of so much anæsthetic as to compel me, after the base of the skull had been trephined, to send the patient back to bed and to complete the operation a few days later. I have heard of one case in which the operation was abandoned on account of this bleeding. Stage iv. *Opening the Base of the Skull.*—A trephine[†] should be applied to the great wing of the sphenoid, at a spot a little anterior and external to the foramen,[‡] and in such a way, if possible, that its disc just impinges on the outer wall of the foramen. As the skull is thinner on the outer margin of the trephine track than on the inner, and as the instrument is applied at an angle, Mr. Rose's caution about the dura mater should be remembered here. Stage v. *Division of the Nerve Trunks and Partial Removal of the Ganglion.*—Any bridge of bone between the trephine opening and the foramen having been cut away, and the opening enlarged sufficiently with Hoffmann's forceps set at different angles, gouge, or chisel and mallet, the trunk of the third division, with its silk guide attached, is traced up to the ganglion, which is gently loosened from its resting-place on the petrous bone. The posterior part of it being then carefully removed, the third and second divisions are resected widely, but no attempt should be made to isolate and divide the first. Stage vi. *Closure of the Wound.*—All bleeding having been checked, the irrigation with lot. hyd. perch. (1–4000), which has been continued at intervals, thoroughly carried out, the wound completely dried, sterilised iodoform is well dusted in, the zygoma is adjusted and secured by silver wire, and the wound sutured accurately with a few points of horsehair. No drainage-tube is needed if the above precautions be carefully attended to. The stitches from the eyelid may be removed at the end of three or four days, at which date a smaller dressing of aseptic gauze, sealed on with collodion, will probably suffice for the wound.

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* Mr. Rose has described this operation with full details (*Brit. Med. Journ.*, vol. i. 1892, p. 261). In reading Mr. Rose's account of his operation, and in weighing his recommendation of it, we must remember that he is speaking from a personal experience of five cases.

† In my case I dispensed with the first two. The wound, though tested severely 324), healed by primary union.

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[*] Mr. Rose writes (*loc. supra cit.*): "The portion of bone which one first reaches in the deep part of the operation is well in front of the foramen. and one is apt to get too far forwards, so that the pterygo-maxillary fissure is mistaken for it. In the third of my cases this actually occurred, and I trephined the sides of the fissure, not discovering my mistake until I found orbital fat protruding from the opening."

[†] A special one is made by Mr. Hawksley, 357 Oxford Street, of small disc, with teeth adapted to the thickness of bone to be cut through, and a long handle to meet the depth of the wound.

[‡] In Mr. Rose's first four cases the trephine was placed, with a blunt-pointed centre-pin, in the foramen, so as to remove a disc of bone half an inch in diameter, with the foramen as its centre. The occurrence of epistaxis and coffee-ground-like vomiting in one case (this eventually did quite well) made it probable that the Eustachian tube had been encroached upon (*vide supra*, p. 325), thus running the risk also of septic contamination from the pharynx.

From my experience of one case, I would suggest that when the bleeding is profuse, and the operation prolonged, it may be well to perform this complicated and most difficult operation in two stages. My case was as follows:

Mr. G., aged 47, a patient of the late Dr. Galton, of Brixton, came under my care in 1892 for inveterate neuralgia of the fifth nerve, chiefly affecting the second division. For this the nerve had been already stretched at the infra-orbital foramen: the relief given by this step was so temporary as to be futile. In October 1893, I performed Carnochan's operation, which gave relief for nine months. At the end of 1894 the patient came to me with return of pain in the palate and back of the upper jaw, and evidence that the third and first divisions were also affected. Rose's operation was performed at Guy's Hospital, March 22, 1895. Mr. Rose's full account of each step would have rendered this operation comparatively easy had it not been for the baffling venous oozing which took place constantly while I was clearing the external pterygoid out of the pterygoid fossa in order to expose fully the foramen ovale (*vide supra*, p. 323). Then the frequent delays entailed by the needful sponge-pressure, and the caution (perhaps excessive on my part) expended in trephining the base of the skull, so prolonged the operation and the anæsthetic that I was compelled to have the patient replaced in bed after removing the crown of bone, but without completing the operation. I may add that, in spite of the care taken, a slight trickling of cerebro-spinal fluid showed that the dura mater had somewhere been pricked, though I could not detect any injury. The patient, after recovery from his collapse, had no bad symptoms of any kind, and on March 27 I opened up the wound, cleared a few clots out of the pterygoid fossa, and, by tracing up the third division by means of a short guide of silk which had been fastened at the previous operation, I defined the foramen. After cutting away a bridge of bone between this and the trephine opening, which had been placed well in front of and a little external to it, I enlarged the opening with gouge and mallet and a small pair of Hoffmann's forceps, and was then able, by following up the third division, to remove what I believed to be the posterior and lower part of the ganglion. No nerve cells were, however, found. I also resected the second division of the nerve; the third division, including the lingual and inferior dental, the auriculo-temporal and buccal, both of which could be recognised, were also resected. The zygoma having been replaced, without any wiring (p. 322), the skin flap was again sutured with a few points of horsehair. No drainage was employed, but the strictest aseptic precautions were made use of. No bad results followed on the opening up of the wound. The eye did not suffer, and the patient went out three weeks after the operation. Eventually the pain returned, and the patient was operated on with success by Mr. J. Hutchinson, jun., at the London Hospital by the intracranial method. He informed me that my trephine-opening had just missed the ganglion.

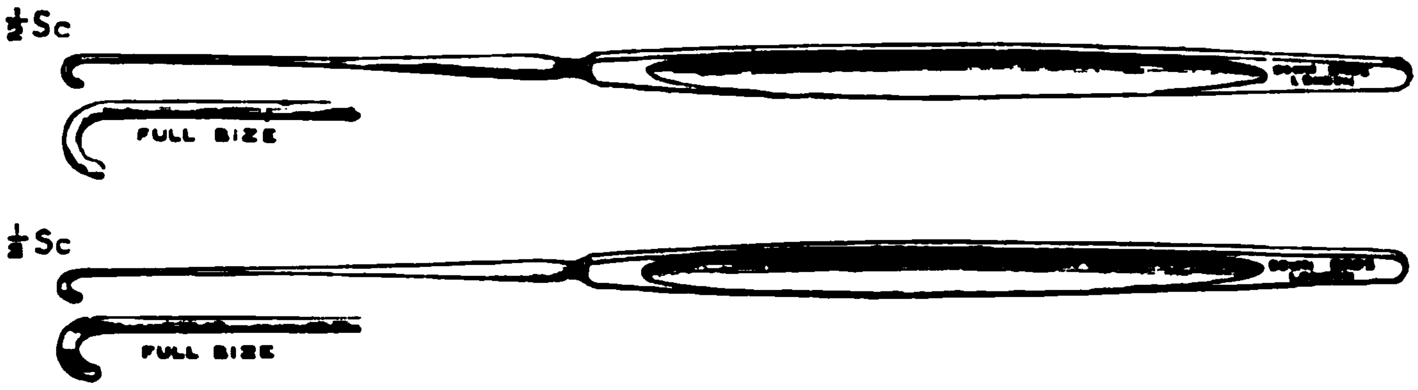
The following are the **chief difficulties and dangers of Rose's extracranial method**:—(1) The limited room and restricted field in which the surgeon has to work. (2) Shock. (3) Hæmorrhage. This, from the neighbourhood of the pterygoid plexus, is certain to be troublesome. Even in Mr. Rose's experienced hands (*Lancet*, 1892, vol. i. pp. 71, 182, 295) this proved to be the case on two occasions: in one it is recorded that only the posterior half of the ganglion was removed, and the anæsthetic area was found, later on, to be mainly confined to the third division of the nerve; in the other case the dura mater and the Eustachian tube were wounded, leading to septic fatal encephalitis. (4) Rupture of the Eustachian tube. In one case there was free hæmorrhage from the nose and mouth during the operation. Death took place four days later (Caponotto, *Policl. Rom.*, 1895, 66–74), (5) Septic encephalitis. In addition to the case given above there is one published by Salado (*Siglo Med.*, Madrid, 1892, 804, 819). (6) Sloughing of the cornea.

It must be remembered that a far larger number of cases have now been operated on by the intra- than by the extra-cranial method, and that it is certain that a considerable number of cases in which the search for the ganglion by the extracranial route has proved unsuccessful have never been published. In comparing the two methods, both the extracranial and the intracranial are operations of great difficulty, and each is beset by very real dangers, but the intracranial, or method of Hartley and Krause, is the one to be preferred, chiefly owing to the less cramped field which the surgeon has before him in the performance of one of the most difficult operations of surgery.

Dr. Tiffany's opinion (*loc. infra cit.*) is as follows: "While the earlier operations followed the method of Rose, that devised about the same time by both Hartley and Krause, independently of each other, receives the preference at present, and, in my opinion, justly so. The temporal route gives excellent access to the ganglion, which can be well seen, together with its branches; while, should experience show that removal of the sensory root proximal to the ganglion is expedient, comparison between the two methods would cease to be possible. Motion of the lower jaw may be impaired after Rose's operation, but it is not after the Hartley-Krause method."

(B) **Intracranial Operations.** — i. **Mr. Horsley's Operation for Division of the Fifth Nerve behind the Gasserian Ganglion.**—In this the Gasserian ganglion is reached by exposing the temporosphenoidal lobe, and then by carefully raising the brain with a broad retractor from the middle fossa. A large temporal flap is made, starting from the anterior extremity of the zygomatic process, running upwards to the temporal ridge, following that line, and descending along it to the posterior or junction of the squamous and lambdoid sutures. The flap having been reflected, the whole of the squamous bone is removed by the trephine and suitable bone-forceps, *e.g.*, those of De Vilbiss (p. 308), or Gigli's saw (p. 306). Anteriorly the middle meningeal artery should be ligatured where exposed in the dura mater. The temporo-sphenoidal lobe is next exposed by opening the dura mater along the full length of the bone laid bare. The above lobe is partly moulded, partly lifted upwards by means of a broad copper retractor gently slipped under it, and the floor of the skull is then easily illuminated with the electric light. The lobe being raised a little more, the upper border of the petrous bone and the edge of the tentorium, which are the guides to the fifth nerve (the nerve entering the dura mater just beneath the edge of the tentorium), must be defined. The site of the canal in which the nerve is lying just above the ganglion must then be estimated, and a small puncturing incision made into it. When it is recognised, the dura mater over the nerve is further slit open. Mr. Horsley, in the only case in which, as far as I am aware, he has published the results of this operation (*Brit. Med. Journ.*, vol. ii. 1891, p. 1249), passed a blunt hook around the nerve behind the ganglion, and, to avoid hæmorrhage from the small branch of the basilar which he believes to accompany the nerve, by gently drawing on the nerve with the hook, tore it away from its attachment to the pons. It is noteworthy that at the moment of avulsion, though the patient was well under the anæsthetic, there was an arrest of respiration, and the pulse could not be felt. This lasted for a few seconds only. The patient, whose condition before the operation had given rise to anxiety, never rallied, and "died seven hours after, obviously from shock."

FIG. 117.



Rose's hooks, blunt and sharp, for isolating and dividing the trunks of the fifth nerve. (Down Bros.' Cat.)

With all deference to Mr. Horsley, I cannot but think the course adopted here, of avulsion of the sensory or great root of the fifth, an unfortunate one. When one remembers the association of this sensory root, by its origin from the fourth ventricle, with the numerous nuclei so closely packed there, and the medulla, one is not surprised that respiration and circulation failed at the moment of avulsion, though the patient was well under the influence of the anæsthetic, and that the operation was followed by fatal shock. Had the root been divided after isolation, the result would probably have been very different, though division of the great sensory root would appear likely to risk destruction of the eye, a result which has followed in several cases, unpublished as well as published.

ii. **Operation of Krause and Hartley* for Removal of the Gasserian**

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* Prof. Krause, of Altona, and Dr. Hartley originated independently, and within a very few months of each other, an operation which is practically the same. Prof. Krause (*Ann. of Surg.*, vol. ii. 1893, p. 362) claims the priority. It must be remembered that in many cases in which this intracranial neurectomy has been employed the second and

Ganglion.—The steps of this intracranial neurectomy are thus given (*Annals of Surgery*, 1893, p. 509):—Before the operation, the eyeball and its lids should be carefully disinfected with boracic acid, and the centre of the two lids sewn together with two or three sutures. This will leave sufficient space for observation of the condition of the cornea, and for syringing the space between the lids. These sutures should be removed about the fifth day, and a Buller's shield at once applied, and employed for two or three weeks after the operation. An omega-shaped incision is made, having its base at the zygoma, and marked by a line drawn from the external angular process to the tragus. From each end of this base the curved and rounded part of the incision reaches as high as the supra-temporal ridge. The incision is first carried down to the periosteum, and the membrane then divided upon the bone. With trephine, bone-forceps (pp. 307, 308), saw, or a chisel,* the bone is divided along the line of the severed periosteum. The dura mater must be protected with a narrow copper spatula while the skull is divided. In this way a flap, consisting of skin, muscle, periosteum, and bone,† is thrown down, exposing the dura mater over a circular area of three inches in diameter. The ends of the incision in the bone below should be quite on a level with the zygoma. The dura mater is next separated from the bone, and the middle meningeal tied if injured by being torn out of its groove. Hæmorrhage from the middle meningeal artery is a very frequent complication, and, as in other operations, may be most difficult to meet. Most of the methods given at p. 215 may be employed. Ligature of the external or common carotid is not to be recommended, as in one case, which occurred in Philadelphia, death of the flap and fatal sepsis followed. Other sources of hæmorrhage are the cavernous sinus, the small middle meningeal artery, and the veins between the temporo-sphenoidal lobe and the inferior petrosal sinus. In three of Prof. Keen's cases, so much hæmorrhage was met with as to necessitate the use of iodoform gauze tampons, and deferring the completion of the operation to a second stage. In one case the amount of gauze used was 37 in. by 6 in., in a second 23 in. by 14 in., and in a third 16 in. by 6 in. Krause also met with hæmorrhage so severe as to necessitate packing with iodoform gauze, and deferring completion of the operation until the fifth day. The dura mater and the brain are now carefully separated from the middle fossa with the finger, and raised with broad retractors (highly polished in order to reflect the light) so as to expose the foramen ovale and rotundum. The site of the carotid artery and the cavernous sinus can also be defined. The second and third divisions are then isolated at their foramina, divided, their cut ends secured with forceps or silk as guides, and traced up, after the dura mater over them has been divided, as far as the Gasserian ganglion. Then the part of each between the ganglion and the edge already cut is resected. In all

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third divisions of the fifth nerve have been resected, and the Gasserian ganglion left untouched. Such cases need watching over a prolonged period, as recurrence is to be feared when the ganglion itself or the sensory root have not been removed (pp. 321, 328).

* The chisels, of special make, are figured by Dr. Hartley. He specially states that in none of the cases was there any evidence that the vibrations necessarily transmitted by the chisel and mallet to the brain were in any way harmful.

† In several cases the bone has been removed, not reflected, and the resulting tough scar has proved satisfactory.

cases of neurectomy the resections should be as full as possible. Mr. Horsley (*loc. supra cit.*), following Hueter (*Grundriss der Chirurg.*, Bd. i. S. 144), considers failure to be due in some cases to excision of too short a piece, permitting reunion of the cut ends. As the amount of nerve trunks removed is not great, the cut ends of the nerves are pushed into the foramina, so as to interfere with any reunion. The dura mater over the ganglion is next raised, and this body removed. This is best effected by seizing the cut stump of the second and third divisions, and slowly twisting out the ganglion. A question which will present itself here is the extent to which the ganglion should be removed. As to this the chief authorities differ. Thus, Dr. Tiffany (*loc. supra cit.*), with the object of preserving vision, holds that only the outer two-thirds of the ganglion, together with the second and third divisions of the nerve, should be removed, the inner third being left. Prof. Keen, on the other hand, would remove the entire ganglion. He believes that the present methods of dealing with the eye (p. 327) are so improved that its preservation is ensured though the whole ganglion be removed. Secondly, any arbitrary line of removing the outer two-thirds and leaving the inner third will leave diseased ganglionic cells if the ganglion is affected. Any stimulus from the first division will excite sensation in these, and thus bring about a return of pain. The wound having been carefully dried out, the brain and dura mater are replaced, and the flap laid down again. The irregular edge of the vitreous acts as a shelf on which the flap rests and prevents its falling in upon the dura mater.

I have spoken (p. 325) of the extreme difficulties of Rose's operation owing to the very restricted field in which the surgeon has to work, and the constant oozing which baffles him so often, especially from the pterygoid plexus. But although I consider that the intracranial method based upon the operations of Hartley and Krause is to be preferred, it is not to be undertaken lightly. While this method is preferable on account of the wider field and the better access it affords, the difficulties here, too, are great, and the dangers grave. Dr. Tiffany, of Baltimore, in his paper (*Trans. Amer. Surg. Assoc.*, vol. xiv. p. 12) gives a mortality of 22 or 23 per cent. In the discussion which followed, Dr. Ransokoff, of Cincinnati, thought that, if it were possible to obtain accounts of *all* the cases operated on, the mortality would be nearer 50 per cent. But perhaps the most striking testimony to the difficulties and danger of the operation is that given by Prof. Keen, of Philadelphia, a surgeon well known for his wide operative experience, and particularly in cranial and cerebral surgery. Thus, in his paper quoted from above he writes: "Even now, after having operated on eleven, I always approach the operation with a certain amount of hesitation."

The difficulties and dangers of the intracranial method will be considered together. The chief appear to be—1. Shock. 2. Sepsis. 3. Hæmorrhage. Several sources may be met with: (*a*) The diploë. (*β*) The middle meningeal arteries; both the chief one in the removal of the bone, and again when the brain is raised from the temporo-sphenoidal fossa. Lastly, one of the smaller meningeal arteries, when the ganglion itself is attacked, may bleed furiously. And the same may occur from the cavernous sinus when the ganglion is being isolated or removed. 4. Septic encephalitis. 5. Sloughing of the cornea.

The question may arise as to whether the removal of the ganglion or intracranial neurectomy should be performed as primary operations, *i.e.*, the very first after it is decided to adopt surgical measures, or whether as many peripheral operations as possible shall be performed first, the ganglion or intracranial neurectomy only being performed as the very last step. Prof. Keen (*loc. supra cit.*) believes that the last is the right step to take, and on these grounds: (1) The balance of evidence points to the ganglion itself being the last of all to suffer, the disease being in many cases at least primarily peripheral, and the ganglion involved by extension upwards. Peripheral operations should therefore be undertaken first, and they should be performed early, *i.e.*, treatment by drugs, &c., should not be persisted in beyond three or four months, the peripheral operation being done at this stage in the hope of arresting the peripheral disease and preventing its upward course, which will in time result in its reaching the ganglion. (2) While the mortality of peripheral operations, which usually relieve for a considerable time, is very slight, the mortality of operations on the Gasserian ganglion is no less than 22 per cent.

STRETCHING THE FACIAL NERVE.*

As will be seen from the remarks made below (p. 331), it is extremely doubtful if anything more than temporary relief, of a variable duration, can be promised by this measure.

Operation.—The following account is taken from Mr. Godlee's paper (*Clin. Soc. Trans.*, vol. xiv. p. 45); the method is that of Baum.† An incision begun behind the ear, about opposite to the meatus, was carried downwards and forwards to a point immediately below the lobule, and then prolonged almost perpendicularly, but slanting a little forwards, nearly to the angle of the jaw. A small transverse incision was also made below the pinna. After exposing the edge of the sterno-mastoid and parotid, these structures were separated deeply and pulled respectively backwards and forwards. As soon as the edge of the digastric appeared, the knife was discarded, and the structures immediately above and parallel with the upper border of the muscle were one after the other pulled up with a blunt hook or forceps and cleaned with a steel director. When the nerve was reached and raised on the hook, the twitching at first increased; a somewhat firmer pull averted it for a time, but it began again on relaxing the tension; a still firmer pull not only stopped the twitching, but caused the right side of the face to pass into a state of complete paralysis. One or two further pulls were given, and the wound closed. The operation was antiseptic throughout. Healing was complete about the ninth day.*

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* The operation given below, that of Baum, is not, accurately speaking, one quite on the face. It may, however, be conveniently considered here.

† The other method is that of Hueter—by an incision 2 inches long in front of the ear, its centre being opposite to the upper part of the lobule. Prof. Keen (*Annals of Surgery*, July 1886, p. 13) gives the following reasons for preferring that of Baum: (1) The scar is hidden behind the ear, a point of much importance in women, in whom this affection is not uncommon; (2) it is less bloody; (3) it inflicts less damage on the parotid; (4) it reaches the nerve directly at its emergence from the stylo-mastoid foramen, before it has given off any branches except, perhaps, the posterior auricular. Thus there is no risk, as in Hueter's method, of the branches to the occipito-frontalis and orbicularis escaping. The above advantages outweigh the greater ease of Hueter's operation.

The performance of this operation is easy in thin patients; in stout and muscular ones it would be decidedly difficult. In different experiments on the dead subject the amount of tension which the nerve would bear differed very much; in some cases it resisted for an appreciable time the strongest possible pull, in others it snapped across with the greatest readiness.

The line for the nerve is exactly parallel with the upper border of the digastric, and it will be found about half-way down that part of the mastoid process which is exposed in the wound, viz., the free anterior border. The great auricular nerve will be in part divided, but as long as the operator keeps in the same plane as the digastric he can scarcely wound any vessel of importance. The deep parts of the wound are in close proximity to the internal jugular vein. The only vessels which should be met with are the posterior auricular vein superficially, and its artery more deeply, but a good deal of hæmorrhage may arise from glandular branches; and Mr. Godlee's advice to keep the wound in a good light, well opened out with retractors, and carefully sponged dry, should be remembered.

Points which deserve Attention.—(1) Finding the nerve.—To avoid needless injury and to shorten the operation, Prof. Keen† found a weak faradic current very useful. A wet sponge was held on the cheek, and a fine wire at the other end was applied to various points in the wound till the nerve was found.

(2) Mode of stretching the nerve.—Prof. Keen advises stretching from the periphery towards the centre. The amount of force to be used he estimates at four to five pounds, and this he thinks can best be achieved empirically, by attempting to lift the head (six to seven pounds), and abandoning the attempt the moment any fibres give way. In other words, the stretchings should be as severe as the integrity of the nerve will allow.‡

(3) Results of the operation.—It appears that while many cases have been, temporarily, very much relieved, as a certain rule, when the nerve recovers itself, the spasms return.

Prof. Keen, in the table at the end of his paper, gives two cases in which the cure lasted much longer, if, indeed, it may not be called permanent—viz., Southam's,§ in which there was absolute relief for five years, and one under the care of Jesas,[*] in which the cure had lasted two years and eight months.

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* The surgeon must be prepared for what took place in Mr. Godlee's case—viz., some troublesome conjunctivitis from the gaping of the lids, which was relieved by mildly astringent collyria, and holding up the lower lid with plaster.

† *Loc. supra cit.*, p. 13. In the moist condition of the wound a strong current will produce muscular spasm at once, but a very weak current will only do so when the nerve is touched.

‡ Two cases are quoted—those of Eulenberg and Schüssler—in the first of
nerve was "physically disorganised" by the stretching, while in the sec
lay in a small loop in the cavity of the wound; yet in each the p
disappeared and the spasms partially returned.

§ *Lancet*, August 27, 1881; *ibid.*, April 10, 1886.

Prof. Keen's concluding words are as follows: "It would seem, therefore, that, whether viewed from the point of palliation or of cure, the operation is, with our present knowledge, to be looked upon favourably. Further observations may show its inutility, but when we consider the utter hopelessness of improvement, much less recovery, from any other means, relief by this operation, even if temporary, is had at a very trivial cost, and would be welcomed by any sufferer, while permanent cure is not impossible."

Mr. Godlee in a second paper,[†] in which he published the result of his first case—after practically remaining absent for nine months, the convulsions suddenly returned subsequently to a severe nervous shock, and gradually increased until they regained all their former intensity—sums up less favourably: "In discussing the question of recommending the operation to a patient, we must not forget that the risk, with due care, is almost *nil;* that a certain immunity from the trouble may be safely promised for a time, and that this period may be very considerably prolonged, and, while Southam's remarkable case remains completely well, there is always the hope that the relief may be permanent. Were it not for this, however, I am afraid that the general verdict would be that the time has come when this small chapter of surgical therapeutics . . . . must be closed."

It is, of course, to be understood that no patient would be advised to submit to the operation without a thorough trial of other remedies, short of nerve-stretching.

And, after submitting to stretching of the nerve, patients should be most careful to avoid any exciting and predisposing causes of a return of their trouble—viz., exposure to cold chills, sudden bright lights, mental worry, and insufficient or improper food.

RESTORATION OF STENO'S DUCT.

Where, after burns, stabs, ulcerations, sloughing, operations for removal of growths, a most annoying salivary fistula persists, the patient suffering from disagreeable hot dryness of the mouth, and from constant irritation and inflammation of the soft parts from the dribbling of saliva, where previous measures—*e.g.*, collodion and heated wire, paring the edges—have failed, the surgeon may adopt one of the following measures:

(i.) This will often succeed in a recent case.

The opening into the mouth is first found, or one in its position made, by passing a fine silver probe from the fistula into the mouth.[‡]

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[*] *Wien. Med. Woch.*, No. 2, 1884, and No. 27, 1887. It is an interesting fact that no paralysis followed in this case.

[†] Both Mr. Godlee's second paper (*Clin. Soc. Trans.*, vol. xvi. p. 220) and Prof. Keen's (*loc. supra cit.*) contain tables, the former giving thirteen, the latter twenty-one cases. Mr. Godlee's case was unwilling to purchase relief from her complaint by submitting to permanent paralysis of the affected side of her face, owing to a dislike of the very ious nature of the deformity.

[‡] to the projection of the mucous membrane, which usually denotes the position d upper molar tooth.

As soon as the oral opening is found or established, the probe is passed from the mouth along the duct, beyond the fistula, up to the gland itself. The other end of the probe is then brought out of the angle of the mouth, curved, and secured by strapping on the cheek, while the fistula is kept as dry as possible, and covered with collodion, in the hope that it will close,* now that the oral opening is re-established.

Mr. H. Morris (*Clin. Soc. Trans.*, vol. xiii. p. 144) has recorded a case which he successfully treated on the same lines, but with a fine catgut bougie, which is much more easily worn than a probe. He also suggests that it would be well if, during any operation on the face for removal of a new growth, it be found necessary to divide the duct, a bougie should be passed at once, and the patency of the duct secured.

(ii.) In cases of longer standing, where the duct is more obliterated, especially at its narrow oral end, and the restoration is not so easy, some such operation as Dessault's must be performed. A fine trocar and cannula are pushed through the cheek from the fistula forwards and inwards into the mouth, following, as far as possible, the course of the duct. The trocar being withdrawn, a small silk seton is passed along the cannula; this is then taken out and the two ends of the seton, the one projecting from the mouth and the other from the fistula, are tied together: at about the end of three weeks (according to the amount of inflammation) the seton is withdrawn, and the sinus established by it is kept open by probe or bougie, as already described.

When the patency of the new duct is thoroughly established,† the external aperture may be closed by collodion, the cautery, or paring the edges, according to its size.

OPERATIVE TREATMENT OF LUPUS.‡

We owe to German surgeons our knowledge that, from the infective power of this tubercular growth, it is impossible, when once it is established, to cure it by constitutional treatment. A further step has been the gradual replacing of local treatment by caustics or the cautery, or by the erasion method of Volkmann (*Germ. Clin. Lect.*, Syd. Soc. transl., p. 97). Lupus is so frequently met with in this country, the deformities which it produces are so odious, and it is so certainly arrested and cured in many cases by local treatment vigorously applied and energetically repeated, that a few practical remarks will be made on the chief methods of treatment.

Before speaking in detail of these methods it will be well to say a few words about **the chief forms of lupus,** and to which of these erasion or scarification is best suited.

I think that for the purpose of treatment the surgeon should keep two great types before his mind. **In one** of these the **lupus deposit** takes the shape of **more or less localised** nodules, tubercles, or nests, reddish or yellowish-pink, often quasi-gelatinous, and prone to attack the cheeks near the junction of the alæ and the upper lip. **In the other the lupus deposit is much more diffused,** usually, too, more superficial and less inclined to form nodules or nests. This type is met with both on the cheeks and nose, but is best seen on the latter. It is, in my experience, the form much the most frequently met with in the surgical wards of a London hospital, and is the one most often responsible for marring the above important features in young patients, usually girls. This is the lupus seborrhagicus of Prof. Volkmann,* the seborrhœa being of secondary importance, the essential point being the fine-cell lupus infiltration of the cutis, which develops most freely in the neighbourhood of the sebaceous glands, in which the cheeks and nose are so rich, and gives rise to an increased secretion on their part.

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* If this fail, a plastic operation of paring the edges and uniting them with numerous sterilised fishing-gut and horsehair sutures will probably be required.

† Sir J. E. Erichsen (*Surg.*, vol. ii. p. 557) suggests the passage of a piece of laminaria tent if the sinus show much tendency to close.

‡ The above account, while introduced here from the greater frequency of lupus on the face, is, of course, applicable to the disease elsewhere.

Caustics.—Mr. J. Hutchinson thus compares the three chief methods of local treatment (*Brit. Med. Journ.*, May 1, 1880): "All are very good, but I unhesitatingly prefer the last [viz., erasion]. If caustics are used, they must be used very freely. I have repeatedly seen a patch wholly cured by a single dressing with chloride of zinc or acid nitrate of mercury. As a rule, these remedies are used too timidly or without sufficient painstaking. They give more pain than the actual cautery, but their sores granulate better and heal more quickly. The actual cautery is comparatively painless, can be easily limited, and at the same time made to act deeply. It is very efficient, but its burns are somewhat slow to heal. The erasion treatment appears to gives less pain, to be very efficient, and to leave a sore which heals rapidly and soundly." From my experience, the use of caustics is open to the following great objection. If used in sufficient strength and thoroughness to eradicate the lupus, they destroy more tissue than is necessary, and leave wounds which are tedious in healing, and scars which are much more conspicuous than those of erasion. If used diluted and with caution, they are liable to leave behind many small nodules of lupus, while, at the same time, they set up a hyperæmia which favours a more rapid spread of the disease which is left. For the above reasons I do not recommend the use of caustics here.

Erasion.—This is most strongly indicated in both the above forms of lupus, whether localised or diffused. Combined with scarification it is the mode of treatment best adapted to the largest number of cases. The best instruments are sharp steel spoons, with oval ends of varying size, some quite small; the best are, in my opinion, two in which the curette and pointed scarifier are combined (Down Bros.). Several sizes of scoops, down to very small ones, are most essential. One prolific cause of the recurrence of lupus is that the large spoons usually employed miss the smaller deposits lurking in depressions in the corium. An anæsthetic having been given, the surgeon, using first one of the larger spoons, goes with deliberate thoroughness over the entire surface of the patch of lupus, using the spoon from below upwards; and if there are several patches, *e.g.*, on the face, he begins with the lowest, so that his work shall not be obscured by hæmorrhage. With the spoon all the overlying yellowish-red, greasy crusts, all the surface below these that the spoon finds to be abnormally soft, *i.e.*, something like a patch of decay in an apple or pear, are deliberately and thoroughly scraped away. The bleeding, which is usually free, is now stopped by firm pressure with iodoform or salicylic wool. The edge of the sore is then in its turn attacked in the same way, the track of the spoon being next smoothed down by running a pair of scissors curved on the flat around the edge of the patch. The surgeon, now that the hæmorrhage is arrested, returns to the surface of the patch. Any suspicious spots are scraped again. There need be no fear of doing too much and thus causing needless scarring. The deeper layers of the corium are naturally tough and dense,* and there is no danger of their yielding to the spoon, the action of which is at once checked when the operator, by the change in the sensation of resistance, is aware that he has reached healthy tissues. The bleeding having again been thoroughly stanched, minute nests may often be found lying in pockets amongst the meshes of the corium. These are a potent source of recurrence of lupus, being left after all that is soft and friable has been scraped away. They are to be dug out with small spoons, or destroyed with the scarifier, finely-pointed sticks of silver nitrate, or fine cautery. While the bleeding is being finally stanched, the operator turns his attention to the vicinity of the lupus patch which he has attacked. The minutest points, specks, and nests are scrutinised and destroyed with a fine-pointed cautery. Where the nose or its vicinity is affected, the inner aspect of the orifices should be inspected in case the mucous membrane is invaded. Before the patient is allowed to come round from the anæsthetic, all red lupus scars are examined. Any deposits in them are attacked in the same way, or, if they are the seat of a diffuse hyperæmia and infiltration, linear scarification is thoroughly resorted to.

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* Prof. Volkmann (*loc. supra cit.*, p. 105) gives the following life-like description of this form: Irregular, reddish-looking patches met with on the cheeks and nose, often covered with "dirty-looking, thin crusts, which are distinctly fatty to the touch. They consist, in fact, of nothing further than an excessive secretion from the sebaceous glands of the skin mixed with epidermis cells. When we have succeeded, with great difficulty, in scraping off this fatty layer with the knife, the underlying skin appears red, sore, and as if studded with fine warts. But if you examine these warty points more closely with a glass, you see that it is by no means a question of papillary elevations, but of a large number of fine holes, which, being closely adjacent to each other, produce the warty appearance. These holes are the enlarged openings of the sebaceous ducts, and you can also see on peeling off single fatty crusts how a fine prolongation of the latter becomes detached from each sm opening."

The best application to the surfaces left by erasion has been much disputed. For myself, knowing the inveterate tendency of the disease to reappear in minute islets overlooked (many of them) at the time of the erasion, I now always use fine-pointed sticks of nitrate of silver to the edge and surface of each erased patch, looking out especially for any suspicious specks or nests in the exposed corium. It is a painful remedy, but this objection must give way to its efficiency. Iodoform is used by some. My chief objection to this is that I believe it, when long continued, to have a tendency to encourage flabby granulations. Lotions of hyd. perchlor. (1 in 2000) have the advantage of promoting asepsis, and of a germicide power which may be helpful here in destroying the bacillus indistinguishable from that of tubercle with which we have to deal. If much pain be present, hot creolin (1 or 2 per cent.) or boracic acid fomentations should be applied. Powdered nitrate of lead is strongly recommended by Messrs. Ashby and Wright (*The Diseases of Childhood*, p. 747): "The repeated application of powdered nitrate of lead has been very useful in our hands, both for lupus and other intractable tuberculous sores; it is somewhat painful, but very effective."

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* As pointed out by Prof. Volkmann (*loc. supra cit.*, p. 114), in cases of lupoid ulcerations of longer standing, an almost fibroid tissue becomes exposed after the diseased parts have been scraped off, a condition which is to be regarded as the expression of reaction in the neighbourhood.

To two other points in the after-treatment I desire to draw attention. One, the need of keeping the wounds clean and as aseptic as possible. It is well known how much the ravages of lupus are due not only to the lupus itself, but also to the presence of pus-cocci, this being especially the case on a part like the face exposed to the air, particularly in regions like the nose and mouth. The second point is that as the wounds granulate there is a marked tendency to scab-formation. Nothing can be more dangerous than the advice sometimes given to leave these scabs alone as the wounds will heal under them. They should be regularly removed daily, with the gentle use of finger-nail or dressing-forceps, and some such application as equal parts of carbolic oil and compound tincture of benzoin applied to the surface itself of the sore that remains to heal. Any prominent granulations should be sedulously shaved down with scissors curved on the flat. If they become persistent or the wound stationary, erasion, under an anæsthetic, is to be at once again resorted to. As in all tubercular diseases which cannot be cured by one operation, the need of repetitions of this, the necessity of prolonged watching and after-attendance, must be clearly accepted by the patient or friends before treatment is commenced.

Scarification.—This is only useful in the more diffuse forms, and as an aid to erasion; it should be employed in two ways. (*a*) Linear. With a fine and very sharp scalpel the surgeon makes scores of fine delicate cuts, parallel with each other, through the diffuse lupoid deposit, crossing these again with similar delicate incisions at a right angle to the first.* Each incision should start and end in sound tissues, the knife being quickly drawn through the lupus deposit. The depth to which the blade is sunk varies with the disease. All the incisions must be made quickly and with a light hand, and care must be taken, as far as possible, not to let them run into each other. The bleeding is extremely free, but is readily arrested by carefully-maintained pressure with iodoform or salicylic wool. To save time an assistant keeps up pressure on one patch, while the surgeon attacks another.

(*b*) Punctiform. Here hundreds, maybe, of punctures are made in the diffused lupoid deposit, a delicate hand being again required, and a fine sharp scalpel-point, the pointed scarifier (p. 334), or a large needle being used. In this case, also, every pains must be taken to place the punctures equidistantly. After arresting the bleeding the surgeon looks carefully over the patch; if at any spots his incisions or punctures are crowded together, with intervening places but little touched, he again goes over the ground carefully.

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* No scarring need be feared from either form of scarification. After three weeks have elapsed, the above incisions, however numerous, if done with proper delicacy, can only be detected by looking for them very closely. In three months it usually requires a lens to find them.

If, after the completion of these operations, the tissues appear tallowy or whitish, there need be no fear of gangrene, the parts being far too well supplied with blood. The object of scarification is, of course, to obliterate the lupoid deposit by the formation of scar-tissue. It is also very useful when a scar, though not again ulcerating, remains obstinately dark bluish-red. Scarification is only to be used as subsidiary to the sharp spoon or other methods, especially when the lupus deposit is diffuse. Used by itself as a means of cure, it is tedious and brings about amelioration, not a cure.

An anæsthetic should invariably be given.* Repetitions are usually required in severe cases, two or three times at intervals of three weeks or more, or whenever minute reddish specks appear and grow.

The Actual Cautery.—This method will be found occasionally useful where lupus attacks mucous surfaces—*e.g.*, the palate, cheek, &c. In such cases, the patient being placed on one side near the edge of the table, the mouth well opened in a good light, all granulating or ulcerated surfaces are first thoroughly curetted with a sharp spoon. With the blade of a Paquelin's cautery these surfaces are then repeatedly treated, and any infiltrated tissue which has not yet broken down, and thus resists the sharp spoon, thoroughly destroyed. Both the surface and edges of the lupus patches should be energetically attacked, the blade being kept at a cherry-red heat. Care must be taken not to encroach upon the orifice of Steno's duct or to approach too closely the upper aperture of the larynx. As I have already said, another and the chief use of the cautery is to destroy minute foci reappearing in scar-tissue after the use of the sharp spoon or other methods. As soon as such reddish specks appear they should be destroyed by the prickers or scarifiers mentioned at p. 334, or, failing these, by a fine-pointed electric cautery, or by the acid mercury nitrate applied with a strong, finely-pointed piece of wood.

Excision.—This is a very useful method for patches of lupus situated on the trunk or limbs. For the face, where lupus is chiefly met with, I do not recommend it. It is almost impossible to make sure, unless by cutting more widely and deeply than is permissible,† that the incisions lie in really healthy tissues. It is extremely difficult to maintain strict asepsis during the healing of wounds near or on the nose and lips; and the same fact interferes with the vitality of grafts in this region. Such wounds are likely to be followed by tedious healing, largely by granulation, and scars, often prominent, and cheloid. Later on, when the excision wound is healed, small red spots of recurrence are very commonly met with in and around the scars. For the above reasons I, personally, do not advise excision of lupus on the face. The only part of the face where I use excision is in cases of extensive lupus of the lips. Here flaps of skin and mucous membrane may be turned up and down, and a long intervening wedge of the lupus-infiltrated tissue excised, the flaps being united by horsehair sutures. When the wound has healed it will be found that the teeth are somewhat unduly exposed, otherwise excision here gives excellent results.

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* Mr. Balmanno Squire recommends (*Brit. Med. Journ.*, May 1, 1880) freezing the skin with ether spray. This so entirely alters the feel of parts that I have not used it. Cocaine has been recommended. I strongly urge general anæsthesia in every case. Lupus, like all tubercular diseases, should be dealt with like malignant disease, no chance being thrown away. For rendering scarification expeditious and precise, Mr. Squire has devised a multiple linear scarifier. This instrument (Weiss) is most useful in port-wine stains; for lupus I prefer fine, very keen scalpels, which will suffice both for linear and punctiform scarification.

† Mr. Bidwell, in the discussion at the Medical Society on Mr. Bruce Clarke's paper (*vide infra*), "recommended that in long-standing cases the subcutaneous fat should be removed in addition to the skin, since it is found to be altered in consistence in these cases." Every surgeon who has operated much on lupus will agree with this advice, but

I would refer those who wish to hear what the advocates of excision of lupus on the face have to say in favour of this method, to papers by Dr. W. Kramer (*Centr. f. Chir.*, 1892. Bd. 8), by Mr. Bruce Clarke (*Med. Soc. Trans.*, 1893, p. 238), and by Mr. L. Bidwell (*Lancet*, vol. ii. 1894, p. 130, and vol. i. 1895, p. 819).

Having tried excision of lupus on the face, and having seen the results of the operation in other hands, I do not advise it here. If used with the freedom which is absolutely requisite it entails needless mutilation, especially on parts like the nose and cheek. It will be said that covering the fresh wound with grafts of living epidermis will prevent any contraction and deformity. Theoretically it will, but practically such a result is by no means certain on the face. Finally, I am of opinion that erasion, if careful and thorough, and followed by adequate scarification, will bring about quite as good results, and with much less mutilation.

The following hints will be found useful in the treatment and after-treatment of a disease which is second to none in its frequency, its inveteracy, its power of disfigurement, and the want of credit to modern surgery which its results still too often show.

1. Unsparing thoroughness is to be employed, especially on the first occasion of operating: there should be no hurrying; hæmorrhage should be completely arrested, and the minute foci spoken of at p. 334, deep-lying as well as superficial, searched for in a good light and energetically destroyed. 2. An anæsthetic should be given each time. 3. The very great probability of relapses and the need of repetition of operations should be explained to the patient and friends, and their co-operation secured from the first. 4. The patients are not only to be kept under observation for a long time, but should be seen with additional frequency in the autumn, winter, and spring. The points in the scars which at once call for operative steps are the appearance of reddish specks or nodules, one or more scars remaining obstinately dark bluish-red or purple, and the persistent appearance of scales or scabs. 5. As in all tubercular affections, while local treatment is of the chief impor-

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Its result on the face [illegible] take [illegible] Kramer [illegible] advise [illegible] should [illegible] or cartilage.

tance, the general health must be looked to and every possible step taken to improve it, more especially by nutritious food and the best bracing air obtainable.

OPERATIVE TREATMENT OF RODENT ULCER.

Owing to the great frequency of this disease on the face, the following remarks are inserted here.

Some Points of Practical Importance.

i. **Propriety of Operation.**—In this form of malignant disease, owing to its extremely slow progress, its very long connection with some well-known flat-topped wart, patients sometimes keep on deferring the operation till their age and the extent of the ulcer cause some difficulty in urging or advising an operation.

The following may help in forming a decision: (1) The extent, depth, and site of the ulcer. A case of moderate severity—say of the size of half-a-crown—may nearly always be submitted to operation. But the difficulty of deciding will be much greater in cases which involve extensively the nose, orbit, and eye, perhaps, especially if the bones on the delicate inner wall are much involved; in the rarer cases in which orbit, nose, and mouth are thrown into one hideous chasm,[*] and those cases, also rare, in which the ulceration extends very widely, though superficially, involving forehead, temple, and parotid region.[†] (2) In all cases of severity the following should be carefully considered—viz., the real age[‡] of the patient (*i.e.*, the age not reckoned by years alone); his habits; how long he will probably live if no operation be performed; whether the disfigurement seriously interferes with the following of an active life; whether there have been any brain symptoms referable to the growth; the condition of the viscera; any liability to erysipelas. Finally, each case being considered by itself, certain conditions will justify operation in otherwise doubtful cases, as when a rodent ulcer, having destroyed the sight of one eye, is creeping across the nose and threatening the opposite one.

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[*] As in Figs. 2 to 6 at the end of Mr. Moore's work, *Rodent Ulcer*.

[†] Mr. Moore (*loc. supra cit.*, Fig. 9) shows one of these superficial but vast rodent ulcers, and his cases vi. and vii. prove the exceeding difficulty, if not impossibility, of completely curing them, even in hands as experienced as his. He thought (p. 58) that the firmness of the skull presented a mechanical obstacle to the complete healing of these large sores. Mr. Hutchinson (*Clin. Surg.*, vol. ii. pl. 65) points out that this extensive form may be very superficial for a long time, may even cicatrise with tolerable soundness, but that, sooner or later, a stage of deep growth and rapid progress is almost certain.

[‡] The late Sir James Paget's words on the risks of operation in old people (*Clin. Lectures*, p. 6) may be quoted here: "They that are fat and bloated, pale, with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not indeed good subjects for operations, yet they are scarcely bad. The old people that are thin and dry and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble and soft-skinned, with little pulses, bad appetites and weak digestive power, so that they cannot, in an emergency, be well nourished." Sir James goes on to speak of their inability to bear loss of blood, the lazy healing of large wounds, the liability of their stomachs to refuse food, their prolonged convalescence, their getting "all but well," and the need of meeting these special dangers with special cares.

ii. **The Operation itself.**—In these days of aseptic surgery, the combined operation by knife and caustics, or cautery, will be preferred to one by caustics alone, on account of its greater precision, the more rapid and more painless healing, the absence of fœtid sloughs, and the diminished liability to erysipelas, &c. The following hints may be found useful in an extensive operation:

(1) To diminish the risks of erysipelas in these patients the parts should be carefully cleansed and kept as aseptic as possible.

(2) Steps of the operation itself and the application of caustics.—The surgeon first makes a groove-like incision* around the whole, or, in a very extensive case, around part of the growth, and well wide of it, and arrests the bleeding by ligature, by leaving on Spencer Wells's forceps, or by sponge-pressure. The next step—that of removing the affected soft parts—is often difficult, owing to their proneness to break away, and thus giving no firm hold to forceps; a sharp spoon is often very useful here, but scraping alone is not to be trusted to. Having scraped away the growth down to tissues apparently healthy, the surgeon scrutinises these most carefully, picking out every atom of yellow-grey granulation-like material, and then again repeating the scraping with careful thoroughness. Where the bones themselves appear eaten into, scraping will not be sufficient, and it will be wiser to go over the worm-eaten surface with a fine gouge or chisel.† In one region especially these must be used with the utmost caution—*i.e.*, where the paper-like bones on the inner wall of the orbit are involved; in this place, if the surgeon is not satisfied with the limited use of the gouge or chisel—which is alone permissible here—he must be content with finally applying Paquelin's thermo-cautery, unless removal of the eye, at the same time, has allowed of the use of zinc chloride paste. In other places this very valuable caustic may be employed fearlessly, as long as precautions be taken to use it in a concentrated form and to apply it in a thick state and as little of it as possible, so that the discharges from the wound shall not allow it to liquefy and run either towards the eye or nose or throat. Formalin is safer, and, perhaps, as efficient.

(3) Question of removing the eye in cases where the conjunctiva is involved.—As a rule, consent should be obtained for this step if needful. Cases clearly requiring it will be those where (*a*) the eye is already useless, or so distinctly deteriorated that it cannot improve; (*β*) where the lids have shrunk off away from it, and left it irritable and painful from exposure; (*γ*) where the disease cannot otherwise be removed or caustics efficiently made use of.

As a rule, if the conjunctiva is much involved, the necessary removal of this will cause sloughing of the eyeball. Occasionally, this only threatens, and then passes away.

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* A pair of sharp, blunt-pointed scissors may be found useful when the lids have to be cut through.

† Mr. Moore (*loc. supra cit.*, p. 51) speaks decisively on this point: "The bone itself must be taken away to a depth exceeding that which has yielded to the disease. Recurrence is otherwise inevitable."

iii. **The After-treatment.**—(1) The chief object here is to keep the wound scrupulously sweet. I prefer, for this, gently packing the wound with iodoform gauze, or, in cases where erysipelas may be expected, dusting with iodoform, and dressing with creolin (2 per cent.) or boracic acid fomentations changed at frequent intervals. Sufficient morphia should be given for the first day or two, and the bowels kept regularly open. If zinc chloride paste has been used. attention must be paid, as already advised, that it does not melt and run into parts like the eye, nose, or mouth, and for this same purpose the position of the patient's head must be looked to. The gauze or lint on which it is applied should be removed at an interval of a few hours, according to the depth which the original disease has reached. (2) If it has been found needful to attack vigorously the bones of the skull, or even to apply some of the caustic to diseased dura mater, and if during the first ten days of the disease fits make their appearance, it does not necessarily follow that cerebral inflammation is setting in. According to Mr. Moore the fits may be slight and the unconsciousness of brief duration, or the fits even severe and attended with coma, but, as a rule, they are recovered from. (3) Secondary hæmorrhage. This is rare after the use of zinc chloride, which forms deep, tenacious, black sloughs, and also seems to me to prevent the risk of pyæmia. But if the cautery only has been used, the amount of fœtor is much greater; and in parts so vascular, secondary hæmorrhage may easily occur if the wound is foul. (4) Recurrence. The patient must always be most carefully watched, and, in the case of extensive and deep disease, any suspicious granulations that appear must be attacked at once. (5) After a severe operation a plastic operation—*e.g.*, *the bringing down of a flap from the forehead*—should be performed; and, this failing, much may be done by a well-made vulcanite mask.*

REMOVAL OF PAROTID GROWTHS.

The question of operation arises here under three somewhat different conditions, viz.:

(i.) In the case of the ordinary parotid tumour.

(ii.) In that of a sarcoma of the parotid, which has often started in the growth just mentioned.

(iii.) In carcinoma of the parotid.

(i.) **Removal of an Ordinary Parotid Tumour.**—These well-known growths, containing a mixture usually of fibro-cartilaginous, myxomatous, and imperfect glandular tissue, require no especial allusion here, beyond the need of—(1) Exposing them sufficiently, (2) Paying strict attention to the facial nerve, and (3) Removing the capsule itself, after the growth has been shelled out, in any cases of doubt—viz., soft consistency, or rapid growth.†

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* As is shown in Figs. 6 and 7 in Mr. Moore's book, *loc. supra cit.*

† In an article (*Guy's Hosp. Reports*, vol. xxvi.) "On the Enchondromata of the Salivary Glands," I wrote, with regard to the removal of these growths: "If the wound be made too small in the first case for fear of a scar, the edges will only be bruised, and primary union prevented. It is not uncommon for branches of the facial nerve to be in

(ii.) **Operation in Sarcoma of the Parotid.**—This disease usually begins in one of the growths just mentioned. This and the next group may, as far as operation is concerned, be considered together.

(iii.) **Operation in Carcinoma of the Parotid.**—The question of the advisability of interfering at all with really malignant growths of the parotid, especially carcinomata, has been much disputed, but as each case must be decided by itself, and as no hard-and-fast line can be laid down here, some useful practical points may be mentioned. On the one hand, attention must be strongly drawn to the fact that reports of operations are often brief, and that too often they are published as soon as the patient leaves his surgeon, and thus two-thirds of their value are lost; on the other hand, I may perhaps remind my younger readers that a malignant tumour in this region is one in which, above most others, he must not allow a wish to relieve a patient to overcome a decision arrived at after careful examination, for there is scarcely any part of the body in which a malignant growth so quickly obtains a firm hold on the surrounding structures—a fact which has even a graver bearing on the operation than the importance of these structures themselves.

A case of carcinoma of the parotid successfully removed, in a woman of 72, is recorded (*Amer. Jour. Med. Sci.*, 1893, vol. cv. p. 144).

At one spot the skin was adherent and ulcerated. The entire gland was extirpated, together with the affected skin, extending up as far as the temporal region. It was found needful to tie the external carotid, and the facial nerve was also necessarily sacrificed. The upper part of the sterno-mastoid, being infiltrated, was removed. The patient was well eight months later.

Practical Points in the Removal of Parotid Tumours.

Characters of the Tumour.—Amongst the most notable of these are—(1) Mobility—viz., how far it can or cannot be lifted up by the fingers from the subjacent parts. (2) Rapidity of growth. (3) Density—thus a great hardness or evident softness will be alike unfavourable, the latter from the fact that such soft growths will break down during attempts at removal, and leave part behind. (4) Pressure symptoms. Of these, dyspnœa, dysphagia, presence of outlying masses in the fauces, and facial paralysis* are of evil omen. (5) Condition of the overlying skin.†

Points in the Operation itself.—To begin with, the growth must be sufficiently exposed by adequate incisions. Probably none will be more

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relation with the capsule of the tumour, and if this has been much handled, or treated by counter-irritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself."

* Prof. Billroth, quoted by Mr. Butlin (*loc. supra cit.*, p. 118), considers that facial paralysis from the pressure of a parotid tumour is a sign that this is probably a carcinoma, for the sarcomata and other tumours rarely produce paralysis by pressure, although paralysis frequently follows the operation for their removal.

† The more adherent, discoloured—viz., reddish-purple—are the integuments, the more unfavourable is the prognosis.

generally suitable than a ├-shaped incision, the vertical portion lying over the large vessels, and the transverse one exposing the facial part of the growth.

If the skin is adherent at any spot this should be removed at the same time. The growth being sufficiently exposed, the extirpation of it had best be begun in front and below,[*] the posterior part being left to the last, as here lie the most important relations, and as these can be most readily dealt with when the growth has been freed elsewhere. During the operation a blunt dissector should be used as much as possible, aided by touches of a pair of scissors, and by dragging the growth in different directions. Every vessel, as soon as cut, should be secured with Spencer Wells's forceps, and the free oozing from the vascular skin and elsewhere arrested by sponge-pressure while the surgeon is engaged with some other part of the growth.

In addition to the free oozing, and the presence of important vessels, other difficulties which may present themselves are the breaking down of a soft growth, thus baffling attempts at complete extirpation, and the strong processes of fibrous tissue which, passing normally from the parotid to some important adjacent structures—viz., the digastric, the internal pterygoid, and the carotid sheath—are now liable to be either increased in density, or softened by extension of the growth.

Two points require especial attention here—viz., the amount of facial paralysis which may be expected,[†] and the hæmorrhage.

Facial Paralysis.—While in the case of a smaller growth, if the nerve has only been bruised, or, when divided, if the ends have been placed in contiguity, union may take place, and the paralysis gradually disappear,[‡] in the case of really malignant growths the question of future deformity must be set aside, and the nerve divided as soon as seen.

Best Modes of meeting Hæmorrhage.—The chief vessels which will be met with are the superficial temporal, transverse facial, occipital, posterior auricular, internal maxillary, and external carotid. The external jugular vein and the large communicating branches between it and the internal jugular are sure to be cut, while the internal jugular vein is almost certain to be seen in the bottom of the wound.

It must be remembered that not only will all the above vessels be liable to be much enlarged, but numerous other unnamed anastomoses will be present.

The common carotid has several times been tied prior to this operation.

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[*] M. Bérard (*Maladies de la Glande Parotide*, p. 240) advises that after the growth has been freed in front, it should be next attacked from below upwards, and not from above downwards, for these reasons:—(1) The blood flows away from the wound, and not over the instruments of the surgeon. (2) The same vessels do not need to be tied more than once. (3) If any large vessel has to be cut, it is secured early, thus diminishing the amount of hæmorrhage.

[†] If the surgeon, especially in less serious cases, when making any deep incision that is needful, can manage not to go above the level of a line drawn horizontally three-quarters of an inch below the lobule of the ear, he will avoid any serious interference with the trunk of the facial nerve, and thus escape the risk of permanent paralysis.

[‡] This gradual improvement is alluded to, with a case in point, in my article, *loc. supra cit.* Mr. Butlin (*loc. supra cit.*, p. 120) suggests a trial of nerve suture here.

In my opinion, ligature of the external carotid with all the accessible branches is greatly to be preferred.

If ligature of the common carotid is to be made use of here, I hold that it should be reserved for those cases in which the surgeon decides to attack a very soft and vascular growth, as here the vessels may be very numerous and difficult to isolate, and ligatures may not hold. In such a case, instead of tying the common carotid and thus exposing the patient to the risks of brain mischief, it would be better to pass a loop of chromic catgut ligature around the vessel, loosely tied, and to ask an assistant to keep up tension on this whenever bleeding takes place. This method seems to have been first used by M. Roux, and later by Mr. Rivington (*Med.-Chir. Trans.*, vol. lxix. p. 72) and Mr. Treves (*Lancet*, January 21, 1888). See Section on "Ligature of the Common Carotid."

In dealing with any large veins the risk of the entrance of air should be prevented by making finger-pressure on the cardiac side, or by securing them with double ligatures before they are cut.

If the wound has become foul—and sometimes in these operations near the mouth and nose it is impossible to keep the bandages from shifting—the surgeon must always be prepared for the accident of secondary hæmorrhage. And on account of the same risk the actual cautery should never be used at the bottom of a very deep wound near to any suspicious tissues, if it can possibly be avoided. If some kind of caustic be required, zinc chloride paste, used with the precautions given at p. 339, would, I think, be preferable from the absence of fœtor with which it works; and formalin perhaps better still.

OPERATIVE TREATMENT OF NÆVI.*

The first question which usually arises is whether these growths should be operated on at all, or whether they may be safely left to themselves. While there is a distinct tendency for nævi, after a term of life, to undergo fibro-cystic change, I doubt if this tendency to spontaneous disappearance is as high as Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 702) puts it—viz., that "certainly more than half are thus naturally cured." In private practice, where a nævus is not extending,† where it is in neither a dangerous nor a conspicuous place, it is justifiable to watch the nævus, remembering that the times of teething and of puberty may bring about atrophy or increase, and that the former, while often spontaneous, is most likely to follow one of the exanthemata. But when a nævus occupies a dangerous site, one where irritation of any kind is likely to bring about hæmorrhage—*e.g.*, scalp, lips, tongue, palate, genitals, rectum, fingers, or toes—or where the site is a conspicuous one, no time should be lost in effecting a cure.

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* I have spoken of their treatment now for convenience' sake, and because of their great importance on the face.

† On this point Mr. Waterhouse (*Clin. Journ.*, Aug. 25, 1897) gives the following hints:—"In certain cases the surgeon can, with some degree of certainty, foretell the progress of the nævus. If the nævus is uniformly compressible, soft, and highly vascular, approaching to a bright red colour, especially at the margins, it is fairly safe to predict that it will increase in size." Mr. Waterhouse advises that the surgeon should hold his hand in all nævi which are not increasing, in infants.

While admitting that, after a year, there is a distinct tendency for a nævus to become stationary, and often to degenerate ultimately, I should advise operative treatment in nearly all cases, for the following reasons:—(1) During its growing and stationary stage the nævus is always a source of anxiety and often of disfigurement. (2) This growing stage commonly lasts for the first year. When a nævus appears to be stationary, or even cicatrising at its centre, it may be spreading at its periphery. (3) In hospital practice there is the greatest difficulty in persuading the mother to put up with any deformity that is remediable in her child. (4) In early life nævi are usually small, and easily and safely cured. (5) The spontaneous cure of a large nævus may leave, by much puckering of the skin, far more deformity than that of an operation. Before describing the different operative measures I would remind my younger readers—(*a*) that there is no method suited to all cases; (*β*) that it is very easy, by using heroic means and doing too much, to cause needless scarring; (*γ*) that during the cure of large nævi in early life the patients are liable to pyrexial attacks and grave malaise. These are not at all uncommon during the cure of large nævi, even though asepsis be maintained.

Different Methods.—I shall only speak at any length of four of these—viz., excision, electrolysis, subcutaneous discission, and the cautery. By one of these, or by two combined, all nævi can be satisfactorily dealt with. Other methods will only be briefly alluded to.

(1) *Excision.*—I use this method very largely for nearly all subcutanous and mixed nævi save those on the face, and for many large cutaneous ones where the scar will be hidden. There is a very great probability of primary union; it is a rapid method, leaving no slough to separate, as is the case with the cautery or ligature, and needing no repetition, as in electrolysis. Two points require notice; one is the risk of hæmorrhage. This is met by working rapidly, by judiciously applied finger-pressure, by keeping wide of the nævus (if the incisions are made outside the nævus the hæmorrhage is not serious, save in large nævi in infants), and, where the bleeding will be severe, by using the method of Mr. Davies-Colley. My late colleague passed two needles, at right angles to each other, beneath the base of the nævus, and twisted around and below them a fine drainage-tube (this may be kept tight by clamping it in Spencer Wells's forceps); below all, two or three silver sutures are passed deeply. After the nævus has been removed, the needles and drainage-tube are withdrawn, and, before bleeding can occur, the sutures are quickly twisted up. The other point is the advisability of leaving any nævoid skin in the excision of a large mixed nævus. While the greater part of the diseased skin should always be removed, narrow strips left on either side will, usually, slowly take on a natural colour. In excision, irrigation with hot perchloride solution (1 in 4000) should be made use of, and the wound carefully united with sutures of fishing-gut and horsehair or, better, wire, which can be quickly twisted when the hæmorrhage is free. Usually no drainage is required. Where, after excision of large nævi on parts concealed, such as the trunk and limbs, it is impossible to bring the edges of the wound together, skin-grafting by Thiersch's method (p. 188) may be employed. I would give a caution to my younger readers with regard to excision of subcutaneous nævi over the abdomen in infants or little children. In these cases there will

be additional need of strict asepsis, for, at this age, the abdominal wall is extremely thin, and, if suppuration occur, a fatal peritonitis may result. In some instances of deep-seated extensive nævi of the side of the face, excision can only be used in conjunction with electrolysis. In such cases excision should, whenever possible, be employed first, before the parts are altered by the electrolysis. One more occasion when excision will, sometimes, be found useful is when a nævus has been cured by some other means and an ugly scar left—*e.g.*, at the root of the nose. If it be possible to get the edges together and to secure primary union, excision will, here, greatly improve matters.

(2) *Electrolysis.*—This method has the great advantage of leaving a minimum of scar* or pucker behind it, and what scar there is, is of good colour. Other advantages are that there is no bleeding, no danger, and little or no pain after the operation. The chief disadvantage is that it requires several sittings—on an average, four or five—and, as an interval of six weeks should elapse between each, the treatment is spread over a considerable time. For this reason the method is not suited to hospital patients, who, usually of limited intelligence, are ill content if the blemish is not speedily removed. With patients of more intelligence and a better rank in life, the following should be insisted upon—1. That, while electrolysis is not expeditious, it is the slow, gradual fading of the nævus which gives the best after-result. 2. That the chief object of the operator is to stop the growth, and then to wait patiently, unless the nævus re-develops or its subsidence is much delayed. Electrolysis is best suited to those nævi which are unsuited to excision, and where the cautery will leave a conspicuous scar—*e.g.*, upon the face, and especially upon the eyelids and nose. In the following account of electrolysis I shall quote from the writings of established authorities on the subject, from whom I have learnt very much.

Dr. W. Newman, of Stamford, writes (*Brit. Med. Journ.*, 1882, vol. ii. p. 248): "The cases for which electrolysis is eminently suited are superficial, dark-coloured, sluggish, vascular growths, which do not possess special or abundant blood-supply. They waste away after one or two sittings, as a matter of moral certainty. Next in order are those nævi which, agreeing with the above in their actual vascularity, yet have much more of surface-covering, and which do not, therefore, so readily declare the conditions of their blood-supply. A majority of these cases will probably be found to be quite amenable to the electric current. On the other hand, the cases in which electrolysis will not, at least as a rule, succeed, are those which are intensely vascular, which are rapidly growing, and which it is fair to conclude have more or less direct communication with blood-vessels."

Dr. J. Duncan (*loc. infra cit.*) thus describes the method which he has done so much to improve: "After trying many batteries of constant current, I have reverted to the Bunsen or Smee with four to six cells of large size. In the Infirmary, where it can be prepared by others, I use the Bunsen of four cells, as giving the largest amount of chemical work with the least tension. But in private, Smee's battery with plates about 4 inches by 6, and having six cells, is most convenient. It is less dirty, has only one fluid, and is equally effective." Before operating, the poles should be tested in saline water, and only used if the evolution of gas is copious and continuous.

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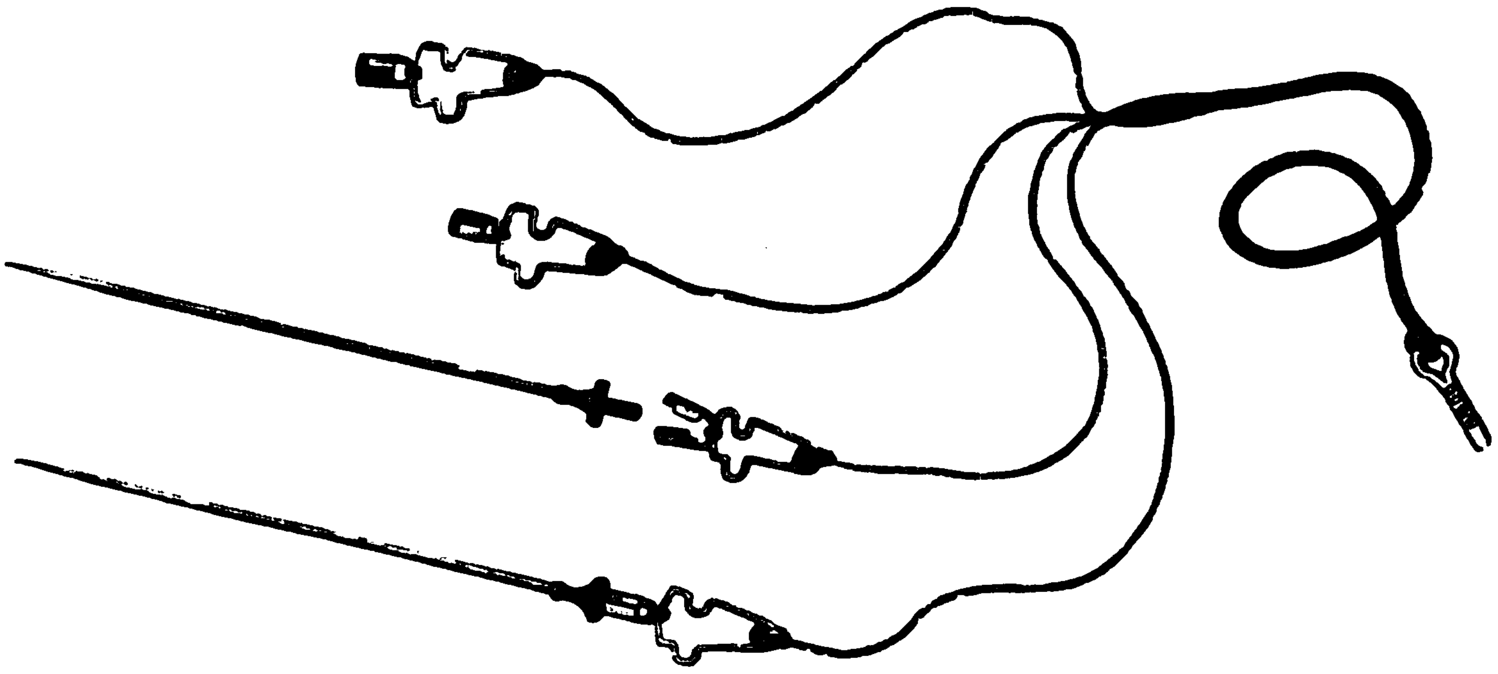
* Dr. L. Marshall (*loc. infra cit.*) claims another advantage for the scar—viz., that it does not tend to contraction in loose tissue like that of the eyelids.

The needles recommended are those introduced by Prof. Fraser and Dr. Duncan. They should be insulated with vulcanite. The length of the exposed point should vary from ⅛ to ¾ inch, according to the size of the nævus. Steel is the best material; but the positive pole, if of steel, requires re-sharpening after each operation, because it is acted on electrolytically. Both poles should be introduced, as giving most work in the least time. In small nævi they are best placed parallel, and equidistant from each other and from the sides of the tumour. In large nævi, Dr. Duncan moves them, especially the negative, from place to place, and introduces them through new punctures. If left stationary, the action rapidly diminishes after ten or fifteen minutes, on account of the slough with which they surround themselves. It is necessary to watch very closely the growing induration round each needle. It increases slightly even after the needles are withdrawn, and the action must be stopped before the skin is involved. If the needles be very slowly withdrawn while the battery is still working, so as to cauterise slightly their track, not a single drop of blood will flow, otherwise pressure should be applied for a few minutes. The nævi should then be covered with aseptic wool and collodion. In large nævi too much must not be done at one sitting or in one place. The slough has to be absorbed, and it is better to establish several small sloughs at different parts than a great mass at one. An anæsthetic is required.

FIG. 118.



Electrolysis needles for use with constant current batteries with serrefine holders. (Down Bros.' Cat.)

Dr. Lewis W. Marshall, of Nottingham (*Lancet*, vol. i. 1889, p. 73; *Brit. Med. Journ.*, vol. i. 1897, p. 273), advises as follows: "I always use the positive pole with one or more needles, according to the size of the growth and its situation. The needle (or needles, as the case may be) is moved about systematically to attack the growth in various parts. This is done without withdrawing the needle after it has remained long enough in one spot to produce some effect. It is wiser at first to work well away from the surface of the tumour, especially in raised nævi which are very florid, to avoid risk of destroying the thin covering. The circuit is completed by attaching a rheophore to the negative pole; by this we avoid an unnecessary puncture, and I find that the process is equally effectual. I have not yet succeeded in finding a good means for insulating needles, and the scar left by the negative needle is brown and very disfiguring. I also prefer to use the positive instead of the negative pole, because it is slower in its action, and therefore less likely to lead to sloughing, and the bleeding on withdrawal of the needle is much less troublesome.* The number of cells used varies somewhat, but my usual custom is to commence with five Leclanché cells (Silvertown Battery Company), and increase according to the effect produced. Ten cells are generally sufficient, but in deep subcutaneous nævi I have applied twenty cells. The amount of tension caused must be very carefully gauged, cutaneous nævi being capable of standing very little. Change in colour to a dusky hue is a good guide to judge when it is requisite to stop the current. On withdrawal of the needle all that is required is to rotate it before pulling to free it, and then paint the orifice with collodion."

Dr. H. Lewis Jones, who has had large experience at St. Bartholomew's Hospital, describes his methods in the *St. Bartholomew's Hospital Reports*, vol. xxx. p. 206. He considers the "unipolar" method the most useful. "Needles of platinum having been connected with the negative pole, the circuit is completed through the patient's body by means of a well-moistened pad attached to the positive pole and placed underneath the patient's back or hips. Small currents are employed, and the nævus is done gradually.† The reason why this plan is preferred is because it gives the operator one set of needles only to manage; the density of the current in the nævus is more easily distributed; the changes produced at each of the needles are alike to one another, and there is little or no bleeding after withdrawal of the needles. Further, the systematic use of the same pole makes it easier to recognise the appearances which indicate that enough has been done, so as to stop the electrolytic action before the stage of complete destruction and sloughing. The objections to the unipolar arrangement of needles are that the current traverses the body of the child, who may, therefore, be affected by electric shocks, and the positive pad, if not carefully managed, may produce an undesired electrolysis in the wrong place. The first of these objections is not serious unless the nævus be situated on the head, and even then with proper care it becomes slight, if one remembers that the needles should be inserted and removed singly and gradually, and the full strength of the current turned on after the insertion of the needles, and turned off before they are all removed. The other danger—that of electrolysis at the seat of the positive pad—can be guarded against by strict attention to the pad and conducting wire; both must be completely covered by moist material, as the smallest portion of uncovered metal will produce destructive effects at the place where it touches the skin." The bipolar method, in which both the poles are inserted into the nævus, is carried out by Dr. Jones by means of his fork-electrodes, in which two to five needles can be arranged, firmly, parallel to one another, thus easily controlled and evenly distributing their action on the tissues. If the needles are used in the ordinary way, care must be taken to keep them parallel, not to allow their points to come in contact, thus producing needless shock, and to keep them at regular distances from each other, from the periphery to the centre of the nævus, so that the whole of the nævus, centre and periphery alike, may be acted upon. If the needle-points converge to, and thus the current is concentrated in, the centre of the nævus, sloughing is likely here, while the periphery will escape. As to the strength of current used, Dr. H. Lewis Jones advises as follows: "The best way of specifying the current is to take into consideration the number of needles used, and to say that for every inch of needle in the nævus, twenty to thirty milliampères is sufficient. Thus, if four negative needles are inserted to a quarter of an inch apiece, the total current may be twenty or thirty milliampères." The needles used may be of platinum, one advantage of which is that they may be attached to either pole. The only objection to them is the difficulty of rendering them really sharp. If steel or copper needles are used they must be attached to the positive pole. The needles should be isolated with vulcanite for a full half of their length, otherwise sloughing will occur at the point of their puncture. Before use the needles should be boiled. When introduced their points must not be allowed to approach the surface of the nævus too closely, or sloughing and, later on, sepsis will occur. The progress of electrolysis is best judged by the induration which takes place, also by any discoloration at the points of entrance of the needles. A greyish spreading zone here indicates that it is time to withdraw and re-insert the needle. Blackening at any part denotes that sloughing will ensue there. Before the needles are withdrawn the current should be shut off, but not abruptly. The only dressing needed is a little salicylic or iodoform wool, kept on with iodoform and collodion till the punctures are healed.

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* Another advantage of the positive pole is that here, as in aneurysm, it produces a clot which is fairly firm and useful in organising; the negative pole, on the other hand, yielding one which is soft and frothy, and of less value.

† "It may be taken as a principle of the electrolytic treatment that the current should not be pushed to such an extent as to cause the nævus to slough. It follows as a rider to this that electrolysis can very seldom be used so as to get rid of a nævus at one operation, unless it is quite a small one, for where this is attempted the result is almost certain to be a slough, and should be regarded as an unfavourable termination. If the nævus is very small, that is to say under a fifth of an inch in diameter, it may be completely destroyed in one sitting."

(3) *Subcutaneous Discission.*—This is an excellent means of obliterating a nævus without scarring, introduced by Dr. Marshall Hall. A cataract-needle or a fine tenotome is passed from a point about a line from the margin of the nævus to the opposite extreme edge of the growth. The needle is then withdrawn almost to its point of entrance, and pushed again through the nævus at about $\frac{1}{16}$ inch from the line of the first puncture, and so on till the lines of puncture take a fan-like shape. The number of times which the needle is passed will vary, according to the size of the nævus, from ten to forty. Each passage must be just removed from the last. Should the needle penetrate the skin, pressure must be applied. This method is best adapted to subcutaneous or mixed nævi of moderate size. After a few weeks repetition may be needful.

(4) *Cautery or Ignipuncture.*—Paquelin's cautery is usually employed, the large blade at a dull cherry-red heat being carefully wiped over a cutaneous nævus, and the fine point used for the subcutaneous ones. This is made to penetrate the skin at one spot, and then made to

traverse the nævus in several directions from the one puncture. It is effectual, but the more I see of it the less I like it, owing to the large scars it leaves. Thus the black sinus or sinuses left after the operation with a red margin of scorched skin suppurate and heal tediously, and with much disfigurement in exposed places. Furthermore, while the slough is being detached the health of an infant or little child often suffers considerably. The small-sized Paquelin's cautery, recently introduced, is greatly to be preferred to that in ordinary use, but best of all is a cautery-battery with the fine platinum points and porcelain burners which any electrician can supply. If, in hospital practice, the surgeon arranges for his nævus cases to attend on one day, there should be no difficulty about the battery being ready. The amount of scarring left is far less than that by the Paquelin's cautery. No anæsthetic is required with either in infants, the pain being momentary. I will take the opportunity here of drawing attention to a most useful warning by Mr. Waterhouse (*loc. supra cit.*), which applies to treatment of nævi by ignipuncture and caustics: "In mixed nævi it is necessary to procure destruction of the subcutaneous portion of the growth, and the cure of the cutaneous part as a rule follows. Times without number have I seen cases in which the treatment adopted has been destruction of the skin portion with caustics. This has resulted in ugly scarring, and the subcutaneous portion of the growth has not been in any way influenced for good." A very simple form of cautery for those stellate patches which appear on girls' faces long after infancy, "spider nævi," is supplied by a needle heated or dipped in nitric acid. An anæsthetic should be given. Another excellent means for healing minute nævi is to make a puncture with a tenotome, and apply for a few seconds a finely pointed stick of silver nitrate.

(5) *Application of Caustics*—e.g., *Sodium Ethylate and Nitric Acid.*—These are suitable for cutaneous nævi. *Ethylate of sodium*, introduced by the late Sir B. W. Richardson, is the one generally used as being less painful.* It should be applied daily for two or three days; a crust then forms: when this drops off the nævus will be found to be cured if the application has been sufficient. *Nitric acid* is much more powerful; careless use of it may produce most odious scars. Whatever caustic is used, it is well to smear parts around with vaseline, and the pointed wood or glass rod used should carry only just enough of the acid, and none to drop about.

(6) *Scarification.*—This may be employed for any cutaneous part of a nævus which is left in a florid state after other treatment, or for port-wine stain, in the same way as advised at p. 350.

(7) *Collodion.*—This may be tried in tiny cutaneous nævi. These can, however, be better treated otherwise. In nearly all other nævi it is a placebo, but not always a harmless one, as it wastes time.

(8) *Vaccination.*—This is not to be recommended. From a very large number of cases which I have seen where this has been used, I am of opinion that it very rarely cures the nævus, while the vaccination is not reliable.

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* The amount of pain is disputed: by some there is said to be very little at the time of application and afterwards. I have not found that this is the case.

(9) *Ligature.*—I have long ago entirely abandoned this, owing to its painfulness, its production of a slough and large scar, and the great risk there is that parts of the strangled mass may escape obliteration.

(10) *Injection.*—This, as usually performed with a preparation of iron, is extremely risky, and should never be made use of unless the nævus is securely surrounded, as with a ring forceps. Several cases suddenly and instantaneously fatal from thrombosis and embolism* have occurred, and a few have been recorded (*Lancet*, 1867, vol. ii. p. 191). I well remember witnessing one in my student days. The late Mr. W. M. Coates, of Salisbury, a surgeon of wide experience, used iodine injection with much success (*Brit. Med. Journ.*, 1883, vol. ii. p. 319). About half a drachm of the undiluted tincture is thrown in slowly by means of a Wood's syringe with a very fine needle. By moving the point, the tincture is thrown into every part. On withdrawing the needle, pressure on the puncture is required for a few moments. The nævus hardens at once and slowly disappears. No scarring results. Mr. Coates considered the treatment by iodine injection quite free from any risk of thrombosis.

If injection is to be employed, pure carbolic acid should be made use of, a minim being thrown in at each puncture, the part being invariably first shut off safely from the general circulation by ring or padded forceps, or by the plan of temporary strangulation by the ligatures figured at p. 270 in part i. of Cheyne and Burghard's *Manual of Surgical Treatment.*

Port-Wine Stain.—This troublesome form of cutaneous nævus is best treated by the careful use of caustics, linear scarification, or the employment of a platinum cautery kept at a white heat. This should barely touch the surface of the stain. Whichever method is used, care must be taken not to destroy too much—*e.g.*, no more than the epidermis and superficial layer of the rete mucosum—in the cases where the stain is thinnest and most diffuse. Cicatrisation will do the rest. Here especially, it is very important to maintain asepsis, *e.g.*, with iodoform or salicylic wool, or iodoform and collodion.

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* Another unfortunate result is alluded to in the footnote, p. 354.

CHAPTER V.

EXCISION OF THE EYEBALL.

EXCISION OF EYEBALL.*

Indications.

i. New growths—*e.g.*, glioma of the retina, melanotic sarcoma of the uveal tract.

ii. In the following cases of injury and its results:

(*a*) The eyeball ruptured and collapsed after a blow.

(*b*) A large, jagged, foreign body in the eye—*e.g.*, a bit of metal, not removable without inevitable disorganisation.

(*c*) If (Nettleship's *Diseases of the Eye*, p. 142) the wound, lying wholly or partly in the dangerous region,† be so large and so complicated with injury to deeper parts that no hope of useful sight remains.

(*d*) If, though the wound be small, it lie in the dangerous region, and have already set up irido-cyclitis.

(*e*) Where a small foreign body—*e.g.*, a shot glancing in cover-shooting—not removable by an electro-magnet, gradually sets up inflammation and shrinking of the eye.

(*f*) When there is a wound in the dangerous region complicated with traumatic cataract.

(*g*) When traumatic cataract has been set up by a wound which is wholly corneal, and therefore out of the dangerous area, and yet severe iritis and pan-ophthalmitis come on in spite of treatment.

iii. As part of an operation for rodent ulcer which has extensively involved the conjunctiva (p. 339).

iv. As part of an operation for removal of orbital tumours—*e.g.*, a glioma or sarcoma which has ruptured the sclerotic, rodent ulcer, scirrhous, sarcomatous, bony growths, &c.‡

Operation.—The chief object is to remove the globe alone, whenever this is possible, leaving the muscles to coalesce and form a stump on which the artificial eye may be supported and be movable. As much conjunctiva as possible should be left.

The surgeon, standing in front, having inserted a spring-speculum between the lids, snips with blunt-pointed scissors through the ocular conjunctiva close to the cornea and all round it, using toothed forceps to lift the conjunctiva, and leaving enough at one side to hold on by the forceps during the next step. This is to open freely Tenon's capsule, and catching up each rectus tendon (beginning usually ith wthe external rectus) with a strabismus-hook, to divide them close to the sclerotic, leaving the cut end of the external rectus long, in order to draw the eyeball forcibly inwards. The superior and inferior rectus are then cut, and the speculum pressed back into the cavity of the orbit so as to make the eyeball start forwards. The scissors, blunt-pointed and slightly curved, are now passed back to feel for the optic nerve, which may be known by its toughness and thickness, and which is now severed with one clean cut. The eyeball being drawn forwards with a finger, the oblique muscles and any remaining soft parts are to be cut close to the globe. Pressure is then to be applied firmly for a few minutes, and for the first ten hours pressure with sterilised aseptic pads and a bandage should be maintained to prevent temporary but troublesome hæmorrhage.

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* As the general surgeon may be called upon to perform this operation at any time, and as it should always be practised on the dead body, it is included here.

† A zone nearly a quarter of an inch wide surrounding the cornea.

‡ For an excellent account of these the reader is referred to Mr. Lawson's article, *Dict. of Surg.*, vol. ii. p. 117 *et seq.*

In the case of a new growth—*e.g.*, glioma—the optic nerve must be divided as far back as possible. The scissors, slightly curved and long enough to reach to the back of the orbit, are introduced on the inner side, and the nerve either cut as far back as is possible before the globe is removed, or, after this is done, the nerve is dissected out and a fresh slice taken.

Where there is any suspicion of growth, as in a glioma of the optic nerve, being left behind, zinc chloride paste should be applied, as at p. 339, or formalin on strips of gauze may be substituted.

Owing to the early stage at which dissemination of intra-ocular sarcomata takes place, and to the tendency of gliomata to creep backwards along the optic nerve towards the interior of the cranium, the prognosis very largely depends upon the earliness of the extirpation. On this account it should be remembered that the earliest symptoms of these growths—viz., impairment of sight from partial detachment of the retina by the pressure of the growth behind it—should be most carefully tested in suspicious cases, this impairment of sight being not usually noticed by the patient, save accidentally on closing the sound eye, unless the growth originates near the yellow spot. If later evidence is waited for, such as evidence of tension and pain, dissemination or recurrence is most probable, while the growth will very likely have perforated the eye, and the severer operation of clearing out the orbit will be required.

The following questions will very likely arise: If there is evidence of general dissemination of the disease, is it expedient to remove the eye, or, if this be insufficient, to clear out the orbit as well? In most cases the answer will be in the affirmative, in order to save the patient pain and the misery of the protruding and ulcerating mass.

If the disease has recurred, is it any use again to attack it? Each question here must be decided by itself. The answer will mainly depend on the amount and depth of the recurrence, and on the completeness of the first operation. Thus, if the eye only was removed at first, it may be wise to clear out the orbit thoroughly.

In a few most distressing cases in children it is well known that both eyes are attacked. The question of operating on the second eye must now be faced. Opinions here differ somewhat. Mr. Butlin[*] thinks that it is better not to operate in such cases, "although the operation may be regarded as justifiable in order to prevent the occurrence of fungous protrusion and the pain and misery which are associated with it." Mr. Lawson,[†] on the other hand, holds that if both eyes are affected, both should be excised, providing that the sight has already been destroyed. He has, on many occasions, removed the second eye to procure temporary relief from the excessive pain induced by the over-distended globe, and when there has not been the slightest prospect of curing the disease. In each case the operation gave immediate and perfect relief.

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[*] *Loc. supra cit.*, p. 88.

[†] *Dict. of Surg.*, vol. ii. p. 124.

CHAPTER VI.

OPERATIONS ON THE NOSE.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE—ROUGE'S OPERATION—REMOVAL OF NASAL POLYPI —ADENOIDS OF NASO-PHARYNX.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE (Figs. 119 to 129).

THESE operations may be divided into those for complete and those for partial restoration.

Indications.—When the patient is healthy and fairly young; when the cause of the destruction—viz., lupus, gunshot injury, syphilitic ulceration, new growth (*e.g.*, epithelioma or rodent ulcer) necessitating removal—is not only checked but soundly healed.*

Thus, when lupus has been cured, and still more in the case of syphilitic ulceration, it will be well to wait six months at least after the disappearance of the disease.

A. **Operations for Complete Restoration.**—I have described several operations, so as to suit the varying conditions met with, but it is increasingly rare to meet with cases requiring complete restoration of the nose. The first three of the following will be found most useful.

1. **Methods by double or superimposed flaps,** *e.g.*, (A) Wood's, and (B) Verneuil's (Figs. 119, 120).
2. **Keegan's Operation** (Figs. 121, 122).
3. **Syme's, from the Cheeks** (Figs. 123, 124, 125).
4. **The Indian or Frontal** (Fig. 125).
5. **The Italian or Tagliacotian.**

Before deciding which operation he will make use of in restoring the nose, the surgeon will investigate the following points: How far is the bony framework of the nose destroyed? If the cartilages, septum, vomer, ethmoid, and nasal bones are much removed, however well made the frontal flap, and however skilfully it is adjusted, it will tend, after looking extremely well at first, to sink down to the level of the cheeks. Wood's and Verneuil's operations meet this partially by their double layers of flaps. If he proposes to take flaps from the cheeks, the surgeon must examine how far these are plentiful, and free from old scars. So, too, if the forehead is to furnish the flaps, how far it is a capacious one and free from hairs.

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* In Sir W. MacCormac's case, quoted below, the tip and alæ of the nose had sloughed in infancy, after the injection of a large nævus with the liquor ferri pernitratis.

The respective advantages of, and the indications for, the above operations will be given in the description of each method.

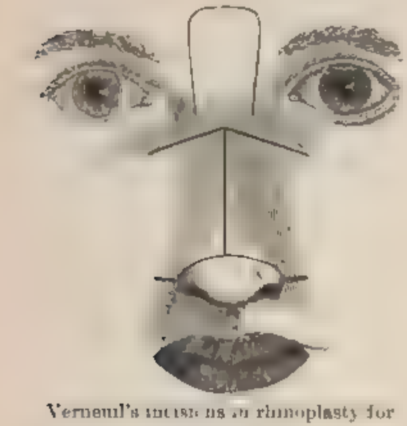
1. **Methods by Double or Superimposed Flaps,** *e.g.*, (A) **Operation of R. H. Woods, by Flaps from Nose and Forehead.**—Sir W. Stokes published a case in which this method gave an excellent result eight months after the operation. He describes the method as having been strongly advocated by Mr. R. Woods (*Brit. Med. Journ.*, vol. i. 1899, p. 325): "The main feature of this procedure is the preservation and reversion of the flap of skin occupying or covering the situation of the destroyed nasal bones. The skin flap, triangular in shape, with its apex above and base below, was turned downwards so that the integumentary surface formed the roof of the anterior portion of the nasal fossa and the raw surface looked forwards. A pyriform-shaped flap, similar to that designed and recommended by Dieffenbach, was then dissected from the forehead, care being taken not to involve the deeper structures covering the frontal bone, a precaution which, I believe, accounts for the unusually small amount of cicatricial deformity which resulted from the operation. The frontal flap, taken somewhat on the left side of the mesial line, was then brought down and inverted by gentle twisting of its pedicle. The two raw surfaces of the triangular nasal flap and the frontal one were then brought into contact, and the edges at each side united by horsehair sutures. The outer portion of the lower part of the pyriform flap at each side of the columella were then turned back and secured by sutures, and the square-shaped portion between them designed for the columella was doubled on itself, bringing its raw surfaces in contact. These were then secured by sutures and pushed back, and the raw surfaces of its edges below brought into contact with the upper edge of the lip, which had been vivified for its reception. These edges were then sutured by fine silk in order to assist in preventing flattening of the new nose. I placed two small leaden plates, kindly furnished me by Mr. Woods, one on each side of the nose, and approximated them by passing silk sutures horizontally through the tissues of the nose and fastening them to the plates. This manœuvre forced the intervening tissues forwards and gave elevation to the new nose. These plates and sutures were left undisturbed for three days and then removed. The advantages of utilising a double flap appear to be twofold. First, there is less risk of contraction, from the inner surface of the new nose being lined with skin; and, secondly, the chances of collapse and flattening of the tissues are diminished owing to the additional thickness of the tissues obtained by the double flap."

Another method by double flaps, that of König, is given below, p. 363.

(B) **Verneuil's Operation by Double Flaps from Nose and Forehead** (Figs. 119 and 120).—This operation, suggested to M. Verneuil by M. Ollier, was employed successfully by him in order to secure permanent elevation of a sunken nose, by superimposing two flaps and thereby doubling the thickness. The patient had discharged a pistol into his mouth, destroying a portion of the hard palate and septum, the nasal bones, part of the nasal processes of the superior maxillary, the spine of the frontal, and the anterior wall of the frontal sinuses. The alæ and tip were uninjured, but much flattened; above them was a broad, deep groove, extending to the middle third of the forehead. The principal indicat[illegible] to rebuild [illegible] bridge of the nose. The latter could be permanently accomplished only by filling in the great cavity which would be left by raising the sunken parts.

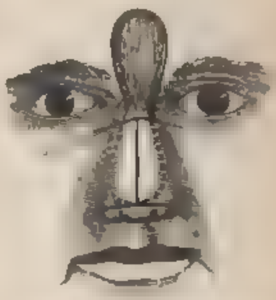
Verneuil made an incision along the median line of the depression and a transverse one at each end of the first, and dissected up the two lateral flaps thus marked out. He then raised an oblong flap from the middle of the forehead, leaving it adherent between the eyebrows, and turned it directly downwards so that its raw surface was directed outwards, its skin surface* looking towards the nasal fossæ. The two lateral flaps were then placed upon it and united in the median line. The raw surfaces united with each other, and the result was a nose elevated ⅓ inch above the adjoining surface. The wound in the forehead is partly closed by a hare-lip pin and sutures, and then or later on healed by skin-grafting. The pedicle of the frontal flap will require dividing and trimming subsequently. In addition to the advantage which this operation possesses of rendering a sunken nose prominent, it produces ultimately, from my experience in one case, but little scarring, the lateral incision-scars fading away gradually into the naso-labial and other sulci. Bone-grafting (p. 364) will be a valuable adjunct here.

FIG. 119.



Verneuil's incisions in rhinoplasty for sunken nose. (Stimson.)

FIG. 120.



Verneuil's double flaps *in situ*. The frontal flap is also shown with its raw surface. (Stimson.)

2. **Keegan's Method of Rhinoplasty.**—This method has been introduced (*Lancet*, vol. i. 1891, p. 419) by Surgeon-Major Keegan, whose name is so well known in relation with lithotrity. As Residency-Surgeon for many years at Indore he had ample opportunities of performing rhinoplasty—slicing off the soft parts of the nose being a very common mutilation in India, especially in the hands of jealous husbands. Such cases are most favourable for operative measures, the patients being young and healthy, and the bridge of the nose left. "The patient having been fully anæsthetised, the cavities on both sides of the septum are plugged with pledgets of wool, to which sutures are attached. The operation is begun by carrying two converging incisions from two points slightly external to the roots of the alæ nasi to two

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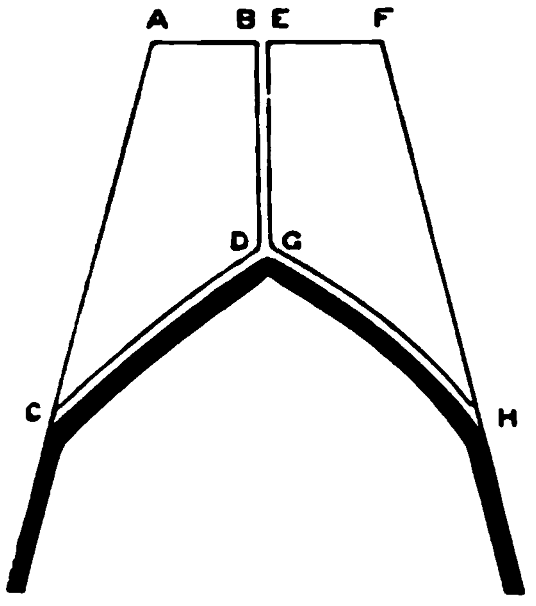
* This should be refreshed. The above account is taken from Stimson's *Operative Surgery*, p. 244.

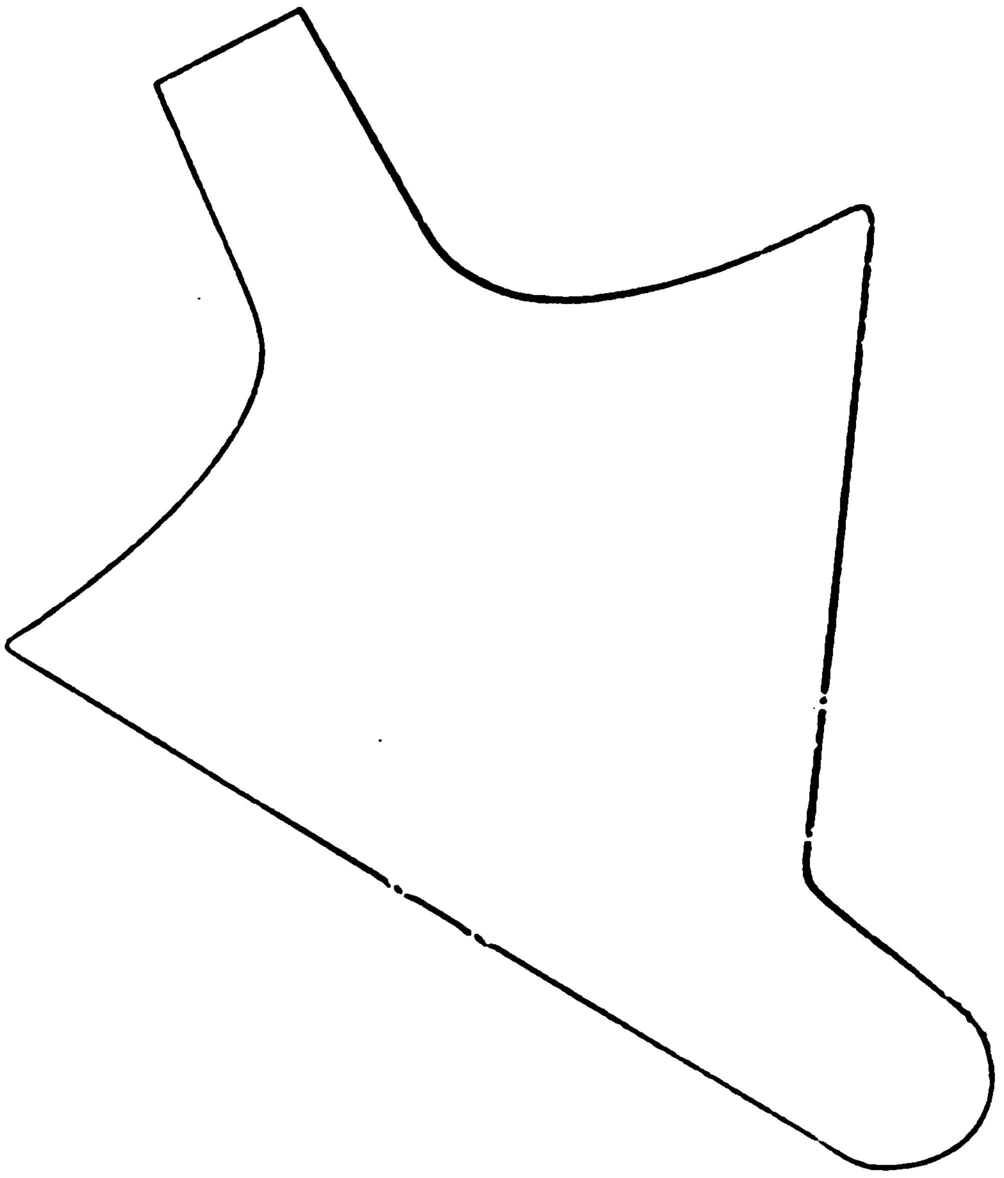
points about three-quarters of an inch apart on the bridge of the nose, where a pair of spectacles would rest. These two points are now joined by a horizontal incision. This horizontal incision is bisected, and a perpendicular incision is drawn downwards from the point of bisection nearly as far as where the nasal bones join on to the cartilage of the nose. In other words, this perpendicular incision follows the course of junction of the nasal bones, but is not carried down as far as their inferior borders. The skin and tissues are now dissected from off the nasal bones from above downwards in two flaps, A B C D and E F G H, as in the appended diagram (Fig. 121). The two inferior borders of the flaps, viz., C D and G H, are not interfered with, and constitute the attachment of the flaps to the structures and tissues which clothe the inferior borders of the nasal bones where they join on to the cartilage of the nose. If these two flaps are reflected downwards, so that their raw surfaces look forwards and their cutaneous surfaces look backwards, it will be found that they overlap in the centre. The surgeon has, therefore, a redundancy which he can utilise a little later on, when he has raised the flap from the forehead. He now proceeds to do this. A piece of brown paper rendered adhesive, corresponding in outline with the flap (Fig. 122) considered suitable to the case in hand, is stuck firmly on to the forehead in a slanting direction. And then a very sharp knife is run round the border of the paper. The paper is now removed, and the flap is quickly raised from the forehead. This flap should embrace all the tissues down to the periosteum, and should be subjected to as little handling as possible. The sides of the gap now left in the forehead are approximated as quickly as possible with horsehair sutures, and it is surprising how small a raw surface is left behind* on the forehead if the approximation of the sides of the gap be judiciously and expeditiously carried out. Attention is now directed to

FIG. 121.



Keegan's method of rhinoplasty.

FIG. 122.



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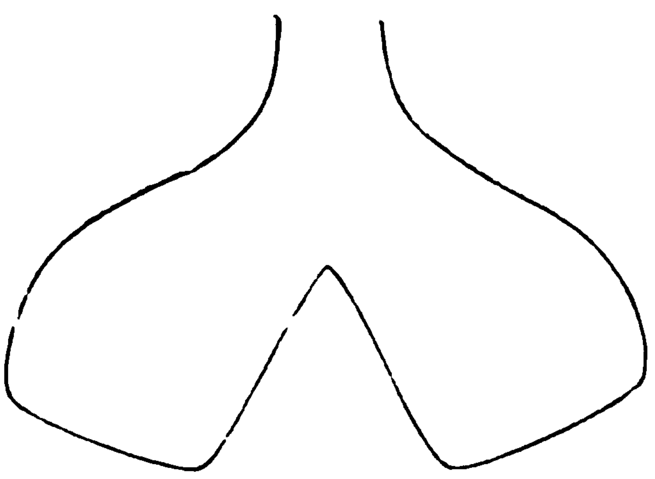
* Any such raw surface should be grafted.

preparing a nidus or bed for the reception of the columna, and this does not require any description. The two flaps, A B C D and E F G H, which have been already raised from off the nasal bones, are now reflected downwards, and, as they overlap in the centre, two triangular-shaped pieces are cut away, and placed in the middle of the gap left in the forehead, in order to expedite the healing of the frontal scar. The forehead flap is now brought down over the nasal bones, and rests inferiorly on the two reflected flaps, A B C D and E F G H, which have been already raised from off the nasal bones. The raw surface of the frontal flap, inferiorly, lies on the raw surfaces of the two reflected nasal flaps, and the nostrils of the newly formed nose are therefore lined inside with the skin of the reflected nasal flaps. The free inferior margins of the forehead flap and the nasal flap are now brought together by horsehair sutures. The columnar portion of the forehead flap is now fixed in the bed prepared for it by sutures, and the two original incisions drawn from the root of the alæ nasi on either side to the bridge of the nose are now deepened and bevelled off for the reception of the sides or lateral margins of the forehead flap. The lateral margins of the forehead flap are most accurately attached, by means of horsehair sutures, to the bed prepared for them. Two pieces of drainage-tubing are inserted in the newly formed nostrils. If the root or pedicle of the new nose is sufficiently broad and is not dragged upon, and the angular artery has not been wounded, then all will go well, and there need be no fear of sloughing. I allow a fortnight to elapse before dividing the root of the new nose, and, in doing so, I cut a wedge-shaped slice out of the root, so that the new nose may not be parrot-shaped. As the inside of each nostril is clothed with skin, the drainage-tubes may be discarded after ten days.”

3. **Syme’s, from the Cheeks** (Figs. 123, 124).—This method is described by its inventor in his *Observations in Clinical Surgery*, p. 56. Besides doing away with a frontal scar, this method enables a nose thus constructed to have its sensations in correspondence with the part from which it was derived.

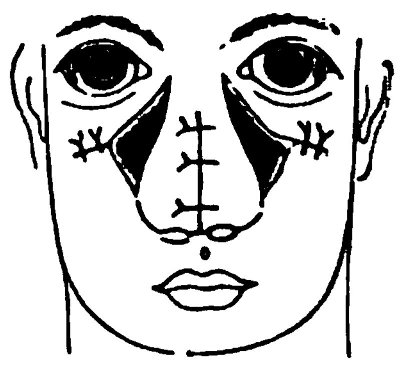
The following drawings show the shape of their flaps, and the manner of their adjustment:

FIG. 123.



(Syme.)

FIG. 124.



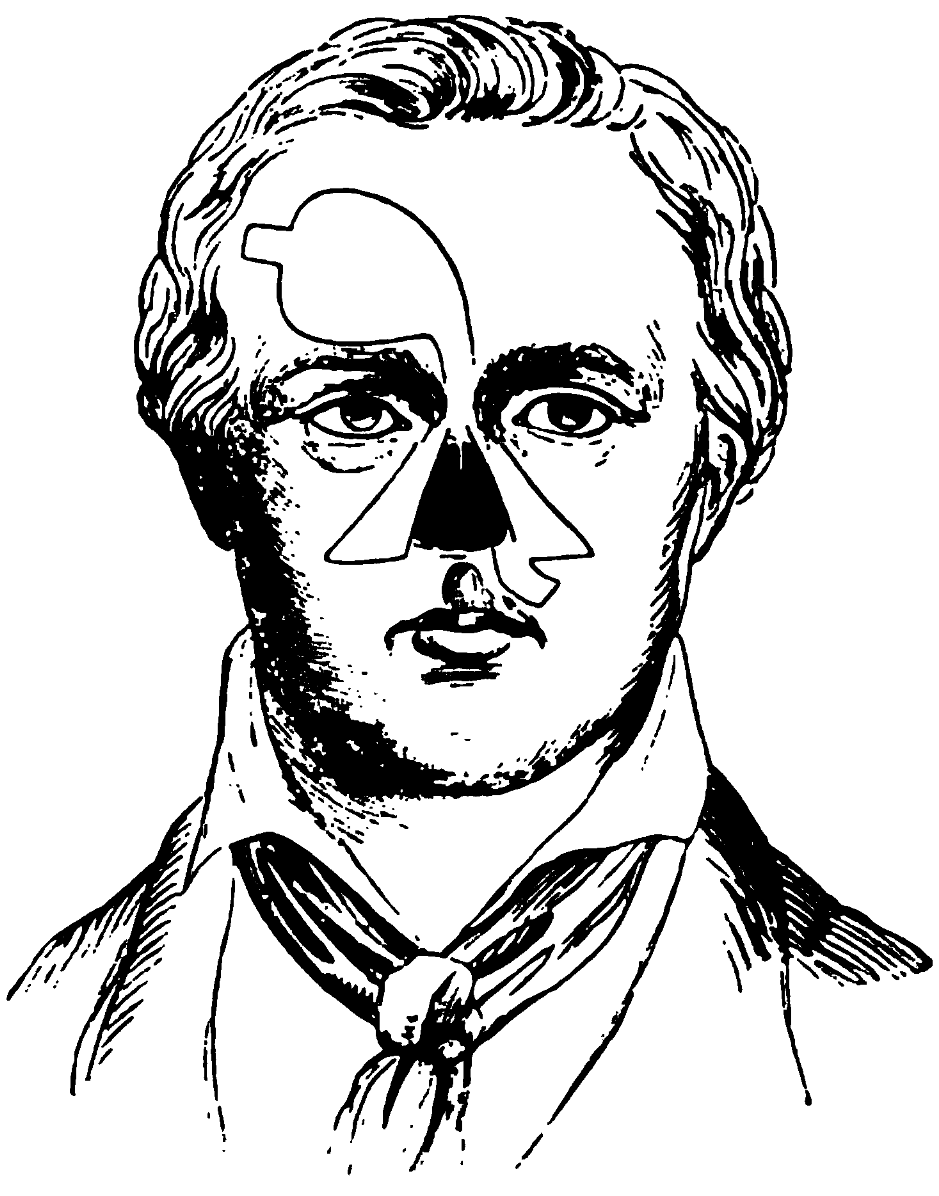
(Bell.)

New flaps of the shape given in Fig. 123 are marked out on the cheeks with their conjoint pedicle above at the root of the nose, between the two inner canthi, extending so far downwards and outwards upon the cheek as to secure sufficient ampleness for the new nose, according to careful measurements already taken. The old nose being got ready by careful paring, the flaps thus marked out are dissected up and united in the middle line by three or four sutures, while the outer margins are fixed on each side to the raw surface at a proper distance from the nasal orifice. Mr. Bell* advises that if any part of the old septum remain, it should be made very useful as a fixed point, a straight needle being thrust through one flap close to its outer lower edge, then through the septum, and out at a corresponding point of the other flap. The edges of the wounds left in the cheeks can generally be partially united by sutures of silver wire or fishing-gut; and the triangular portion, which must be left to heal by granulation, proves an advantage, as by its depression it enhances the apparent height and prominence of the new organ. The cavity of the new nose should, as long as is needful, be kept at first gently supported and distended by drainage-tubes drawn over pieces of catheter, through which the patient can breathe.

4. **The Frontal or Indian Method.**†—This method should be used when the soft parts of the cheeks are insufficient, when they are too cicatricial, or when an operation making use of them has failed. Its chief objections are the large frontal scar, and the liability of the single flap, though abundant and prominent at first, to shrink an fall in later on.

A piece of gutta-percha or leather is so cut that, when folded, it is of suitable shape and size for the new organ; it is then laid, opened out, upon the forehead, and the dimensions marked out with an aniline pencil or tincture of iodine. The flap thus drawn should be of the shape in Fig. 125, and, owing to the retraction of the skin, should measure a quarter of an inch more than the model in every direction. The average dimensions of the flap are thus given by Sir J. E. Erichsen (*Surg.*, vol. ii. p. 608): When the whole nose requires restoration, it is usually necessary to make it about two and a half to three inches long, and from three to three and a quarter inches wide at its broadest part.

FIG. 125.



Flaps from forehead. Also flaps from cheeks. (Skey.)

For the frontal flap, thus mapped out, a bed is now prepared by paring the old nose into a raw triangular surface; in doing this the knife must be used obliquely, cutting from without inwards towards the middle line, so as to leave a grooved surface sloping

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[*] *Manual of Surgical Operations*, fourth edition. p. 176.

[†] Introduced into European surgery by Mr. Carpue in 1816.

inwards. The warning of Erichsen (*loc. supra cit.*, p. 609) should here be remembered, not to remove the parts too widely, lest the cheeks later on retract and flatten out the nose. The bleeding being arrested by sponge-pressure, torsion, leaving on Spencer Wells's forceps (but not in this case by ligature), and covering over the raw surface with lint wrung out of warm boracic-acid lotion, the frontal flap previously marked out may now be raised. This is done by running a scalpel down to the periosteum, along the traced line, taking care that the pedicle be sufficiently long to bear a little twisting, and sufficiently broad and thick to secure the presence of one if not both of the frontal arteries. To avoid any risk of stoppage of its blood-supply, and sloughing, it is well to place the incision for the pedicle a little obliquely, with one side descending a little lower than the other—viz., on the side to which the flap is to be twisted. Where the level of the hairy scalp admits of it, this flap should lie a little obliquely, the tension being thus lessened. Where necessary, the flap may be taken transversely above one or other eyebrow; but the objection to this is, that the retraction of the scar upon the forehead draws the corresponding eyebrow upwards (Stimson). The frontal flap, however placed, is now raised from below upwards, so that the necessary hæmorrhage is rendered as little embarrassing as possible, and with no more handling, or pinching with forceps, than is unavoidable. The knife should be kept away from the flap towards the periosteum, and used in the same plane throughout, without any scoring whatever. The hæmorrhage, free at first, is readily arrested by forci-pressure (leaving on Spencer Wells's forceps for a while) or by sponge-pressure. The flap being sufficiently raised to hang freely and without tension, is then twisted slightly to one side (that on which the pedicle has been cut longest), and brought down and adjusted to the pared edges below by means of numerous fine sutures of salmon-gut, fine silver wire, and horsehair, all being introduced with very small needles.

If the condition of the forehead has admitted of taking a columella from there, an appropriate groove must also have been cut in the upper part of the median line of the lip, and the two carefully adjusted. If no columella can be taken from the forehead, the upper lip must furnish it, either now, if the patient's condition admits of it, or later on, when the pedicle of the frontal flap is divided. If no columella is made now, the flap, when attached, must be supported by gently introducing appropriate-sized plugs of iodoform gauze out of lysol lotion. If a columella is made, two bits of drainage-tube or Jacques' catheter are introduced. The parts, being painted with collodion and iodoform, are well covered in with salicylic wool, but in keeping this in position no pressure must be made with bandages on the new nose.

The forehead wound, on which sponge-pressure has been made, is now partially closed with one or two hare-lip pins and sutures, but in introducing these great care must be taken not to constrict the pedicle of the frontal flap. Now, and later on, healing may be here promoted by skin-grafting by Thiersch's method (p. 188).

The chief points in the after-treatment are not to change the dressings too frequently, to use the utmost gentleness in doing so, to remove t[illegible] gradually, and to be on guard to prevent the onset of erysipelas or of secondary hæmorrhage. The former will be known by a sudden rise of temperature, vomiting or nausea, and is best treated by hot creolin fomentations and by a sharp purge. Hæmorrhage may occur, according to Sir J. E. Erichsen,* as late as the ninth day. It must be met by careful plugging with aseptic gauze dusted with iodoform or wrung out of turpentine.

The flap remains œdematous for some time, but, if not going to slough, it will be found warm and sensitive. If too much swelling persist, careful punctiform scarification should be used.

Separation of the root of the flap.

Three months after the first operation†—*i.e.*, not until the flap has finished shrinking—the pedicle is divided with a narrow straight bistoury and cut somewhat wedge-shaped, with the apex upwards, an appropriate resting-place being fashioned for it in the skin beneath, which, up to this time, has not been touched. A few of the fine sutures already mentioned are then inserted.

If the patient has been feeble, or if the cheeks are very cicatricial, and thus the new blood-supply to the frontal flap be insufficient, some sloughing may take place, but this is rare.

Formation of a new columna.

If this was not made at the time of the first operation, it should be done at the same time that the pedicle is divided. It is rare that a forehead is sufficiently high to obtain an adequate columna, and the additional thickness and vascularity of the lip make it much more desirable to take one from here. Two assistants, with a finger and thumb at each angle of the mouth controlling the coronary arteries, and at the same time making the parts tense, the surgeon, with a straight narrow bistoury, transfixes the root of the lip just to one side of the middle line and cuts straight down through the free border; a similar incision is made on the opposite side of the middle line, and a narrow strip, about a quarter of an inch in width, is thus detached save above. It is well, in a man, to shave off the skin and hair follicles, and the tip being pared, and the remains of the old columna appropriately freshened, the frænum is freely divided, and the new columna united to the remains of the old and to the alæ by one or two fine sutures. The cut surfaces of the lip are then brought most accurately into apposition with a silver wire suture opposite to the coronary arteries, and several points of fine salmon-gut and horsehair. A few more are next inserted to further adjust the columna.

5. **Italian or Tagliacotian Method.**—This is but very rarely made use of in this country owing‡ to the irksomeness which the needful position entails, and the need of a complicated special apparatus.

On the other hand, the absence of any additional scars on the forehead and cheeks, and the abundant flap which can always be obtained, are so important that it may be thought worth while to try this method in female patients who have sufficient time and means, who object to the forehead scar, and who will put up with the inconvenience of cramped restraint for two or three weeks.

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* *Loc. supra cit.*, p. 611, is mentioned a case of Lord Lister's, in which hæmorrhage took place on the ninth day, the patient losing over a pint of blood.

† The time usually given—*i.e.*, four to six weeks—so as to allow of establishment of the blood supply to the flap, is insufficient.

‡ In cases where the destruction is very great, where other methods have failed, where the skin available on the face is much scarred or of doubtful soundness, the Tagliacotian method is especially indicated.

Sir W. Mac Cormac brought a case before the Clinical Society* in which this method had answered well in a girl aged 16. The following account is taken from his paper. Means for keeping the patient's arm in the needful position for the requisite period were thus provided:

> "A pair of ordinary stout well-fitting stays were first procured, to which were attached two perinæal straps, to prevent displacement upwards. A helmet, partly made of leather, was connected with the stays by a leather band running up the centre of the neck and back. A leather armpiece, strengthened by a steel band, was moulded so as to extend from the wrist to the shoulder, where it was buckled to the stays. The wrist and hand were fastened to the helmet by a gauntlet, while the elbow could be fixed steadily in any required position by straps running from it to the stays, and to the sides of the headpiece, so that there was nowhere any undue strain, the pressure being so evenly distributed that each strap was almost slack. This apparatus was next applied for some days beforehand, so that any point of undue pressure might be remedied. The girl was able to sleep soundly in it, and it gave promise of proving perfectly efficient. Meanwhile I modelled on the deficient nose a gutta-percha substitute, and from this was able to project on a flat surface the extent of the deficiency. The first part of the operation was performed thus: A flap was marked out on the inner aspect of the left upper arm, more than double the actual size of the estimated deficiency. The left arm was the one chosen to supply the flap, and the right side of the nose the one first operated on, the septum being fashioned at the same time. The flap was left attached to the upper part of the arm by a broad long pedicle, and so arranged that there should be no traction whatever upon it, whilst the raw surface from which it was taken should be accessible for daily dressing. With the flap I dissected up the subcutaneous fat down to the muscular sheath. Immediate retraction both of the flap and of the denuded part of the arm took place to a large extent, so that the raw surface on the latter was almost co-extensive with the whole inner surface of the girl's arm, the flap appearing quite small in comparison. I now made a slightly curved incision, nearly parallel to the free border of the nose on the right side, and about three lines above it, corresponding, in fact, to where the alar furrow should normally exist. This incision was prolonged some little distance into the cheek in the line of the cheek furrow, whilst the remains of the septum were split open in the median line. This nasal flap could now be turned down so as to become horizontal, or rather a little depressed below the horizontal line, to allow for retraction of the ingrafted piece. A triangular gap, the apex pointing towards the cheek, was thus left exposed on the right lateral aspect of the nose, and into this the triangular-shaped piece from the arm was inserted, and accurately attached by suture, the portion to form the septum being sutured in the groove already formed by splitting the septum. In this way there was no paring of edges, nor was a single particle of nose tissue sacrificed, whilst by having so large a line of attachment, being almost surrounded by living tissue, the new flap was much more likely to adhere satisfactorily in the first instance, and from its freer blood-supply less prone perhaps to subsequent contraction." Union took place in great part by first intention, some suppuration setting in on the eighth day, owing to the indifferent plastic power of the subcutaneous fat. Healing was not complete for nearly three weeks. At this date the operation was completed by detaching the flap from the arm, cutting this so as to give it a triangular shape,

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* *Clin. Soc. Trans.*, vol. x. p. 181. Three figures are given, of the patient before and after the operation, and of the apparatus used.

and preparing the left side of the nose to receive it in a manner precisely similar to the right side. The perfect vitality of the now completely severed tissue of the arm was made apparent by copious hæmorrhage, and healing was complete in a fortnight. After the first forty-eight hours scarcely any inconvenience was felt from the apparatus, save for a slight excoriation on one shoulder. The result was good, but it was expected that further contraction would much improve the aspect of the nose, the new organ being fully large.

The final result of complete rhinoplasty is rarely satisfactory. "The nose is at first very good, but it soon shrinks so seriously that finally it merely presents a more or less shapeless protuberance of skin, not a nose in any real sense. The art of rhinoplasty consists in making a nose with a good profile, long, high, and pointed; but this, as a permanent result, is seldom attained" (Tillmanns's *Surgery*, Amer. transl. by Tilton, vol. ii. p. 287).

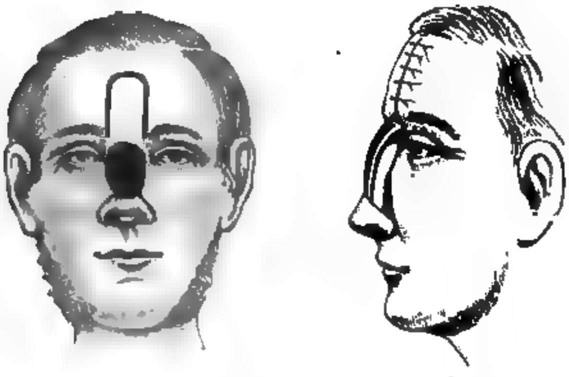
To meet this ultimate shrinking, which is inevitable where the bony nose has been destroyed, attempts have been made in three directions:

A. **Taking bone or periosteum from the forehead or any remains of the bones of the nose.**

B. **Grafting bone**—*e.g.*, that of a rabbit—*i.e.*, **so as to restore the bony bridge.**

C. **Employing a framework of gold,** &c.

Fig. 126.

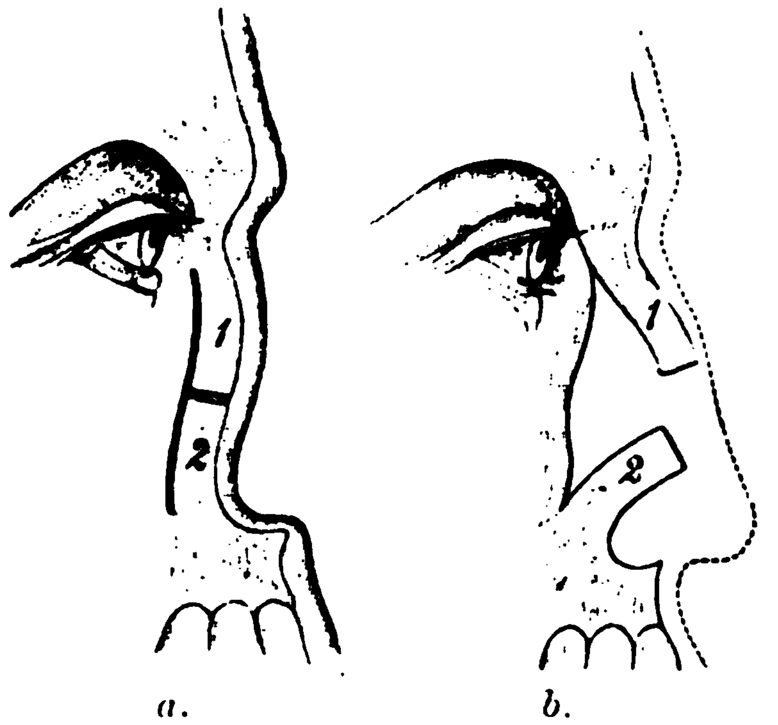


König's method of rhinoplasty. (Tillmanns.)

A. **Taking bone or periosteum from the forehead or any remains of the bones of the nose.**—The following are instances of this method. König makes use of a double flap from the forehead. "The soft parts of the nose are divided by a transverse incision at the deepest part of the depression, and then drawn downwards and forwards. The gaping defect which thus arises is bridged over by an oblong flap of soft parts and bone, three-quarters of a centimetre to one centimetre broad, taken from the root of the nose and the lower part of the forehead, and detached from the frontal bone with a chisel (Fig. 126, *a*). This flap of skin and bone, with the bone surface turned outwards, is then sutured to the borders of the skin of the soft parts of the nose in such a way that the latter projects (Fig. 126, *b*). Over this framework of bone one now places a flap from the forehead, from the frontal region, and sutures it in place" (Tillmanns, *loc. supra cit.*). If, for fear of both the flaps perishing, taking two from the frontal region is objected to, the first may be grafted with skin or covered in by two lateral flaps drawn from the sides of the old nose and cheeks.

The bony framework has also been taken from the bones of the nose. "Langenbeck and Ollier (Fig. 127, *a* and *b*) cut one or two strips from the bony margin of the apertura pyriformis, on each side, by means of a small saw (Fig. 127, *a*), after the skin has been divided by a perpendicular incision and dissected back on each side. The strips, still maintaining their connection with the aperture, are then loosened with an elevator, raised like the rafters of a roof over the defect (Fig. 127, *b*), and, with the previously formed skin flaps, sutured together in the region of the nasal bones. What is left of the nasal bones is then sawn perpendicularly from the nasal processes of the superior maxillary bone and bent upwards. Over the framework of bone which is thus formed one lays the flap from the forehead. But this very ingenious method gives no better permanent result than the transplantation of periosteum" (Tillmanns).

FIG. 127



Langenbeck's and Ollier's method of rhinoplasty. (Tillmanns.)

B. **Grafting bone**[*]—*e.g.*, that of the rabbit—so as to restore the bony bridge. This method, made use of by Mr. Watson Cheyne (*Clin. Soc. Trans.*, vol. xxxiii., 1899, p. 218) with great success in a case of partial rhinoplasty, will probably be much used in the future for re-forming the bony framework of the nose, either in place of taking bone and periosteum in the frontal flap, or in cases where this method has failed.

"The patient, æt. 18, had received a severe injury to the bridge of his nose (? fracture) when twelve years old, this being followed by suppuration from the nose, and, during the next few months, by discharge of portions of the nasal bones. The result was loss of the bony bridge. There was practically no bony bridge present; some rough bone, no doubt of periosteal origin, could be felt covering the space between the two maxillæ in the situation of the nasal bones. There was, fortunately, very little tilting forward of the tip of the nose, and it was not necessary at the operation to cut into the nasal cavity to rectify this deformity. The patient having been anæsthetised, a curved incision with the convexity to the right was made, beginning above rather to the left of the middle line at the root of the nose, and terminating below rather to the left of the middle line about half an inch below the commencement of the cartilage of the nose; the convexity of the curve at its centre extended on to the cheek. The incision at the upper part went down to the bone, and at the lower part to the nasal cartilage. The flap was then turned over to the left, an attempt being made to peel off the periosteum from the nasal bones, which, however, failed owing to the great irregularity of the new bone. While the bleeding was being arrested by pressure, a rabbit was killed by chloroform. immersed in bichloride of mercury solution (1 in 2000) to fix the hair, and rapidly skinned by one of the dressers. One of the thighs being then disarticulated at the hip, the soft parts over the femur were detached, the periosteum being left, and with a pair of cutting pliers the bone was split up longitudinally into several fragments. The wound being now uncovered, a fragment, about two inches in length, was first inserted into the nasal cartilage at the lower part, pushing down the tip of the nose, and then wedged against the frontal bone at its upper part. Four or five smaller fragments were now laid around this till the necessary height for the bridge was obtained. The skin flap was then replaced, but before it could be made to meet it was necessary to undermine it well towards the left side. The wound healed by first intention, but ten days after the operation a little glairy fluid was let out at the upper part. The result, nine months later, was excellent.

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[*] Hardie and others have replaced the bony framework, causing the freshened tip of the left forefinger to heal into the vivified upper angle of the nasal defect. Fifteen weeks later the finger was amputated in the middle of the upper phalanx.

In another case Mr. Watson Cheyne made use of the same method with equal success.

The chief point about this case is that it was found necessary, here, to divide the nasal cartilage transversely on account of the marked tilting forwards of the nostrils, and at the same time a narrow flap of bone and soft parts was turned down from the frontal bone to keep this in its place and form the basis for a bridge. When this had healed, rabbit bone was inserted in the manner just described.

C. **Employing a framework of gold, &c.**—Attempts have been made, especially on the Continent, where the ravages of tertiary syphilis seem to be still much more common than with us, to replace the bony framework with frames of gold, amber, and wire covered with india-rubber. In two cases, in which the use of gold in this country came to my knowledge, the result was a failure. This method will probably be entirely replaced by that of Mr. W. Cheyne.*

Causes of Failure after Complete Rhinoplasty:

1. Gangrene and sloughing.
2. Secondary hæmorrhage.
3. Erysipelas.
4. Shrinking and consequent shapelessness of the new nose.
5. Destruction of the new nose by recurrence of the old disease.

B. **Operations for Partial Restoration of the Nose.**—These are very numerous, and have usually been designed for special cases. A few only will be alluded to here.

i. In cases where the lower third of the nose is left untouched and the central portion especially destroyed: (*a*) Small square flaps are raised from the sides of the nose and cheeks, to which a small flap from the forehead may be added, and united in the middle line. (*β*) Another method is shown in Fig. 125; it was made use of by Mr. Skey (*Operative Surgery*, p. 523).

ii. **Single Lateral Flap.**—This may be taken in many different ways. (*a*) From the cheek, at the side of and below the nose. This flap may be raised horizontally, the pedicle lying outwards on the cheek. This is merely a modification of Syme's operation. I have found it give excellent results after operations for lupus, rodent ulcer, and epithelioma, where the cheeks are fairly full and rich in fat (Fig. 128, A). (*β*) From the opposite side (Langenbeck). Here the flaps are taken vertically. The apex of the flap is left attached to the inner angle of the eye, on the same side as the deficiency, while the base comes from the ala of the sound side (Fig. 128, B). (γ) M. Denonvillers' method. A border that has already cicatrised is made use of so as to prevent subsequent narrowing. A triangular flap is marked out by incisions shown in Fig. 129, the pedicle being internal. The flap, having being carefully raised with a strip of cartilage in its lower margin, is displaced downwards into position.

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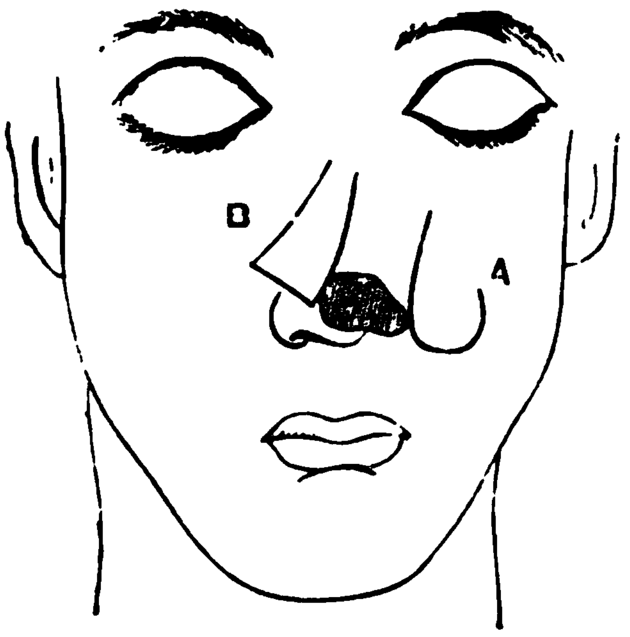
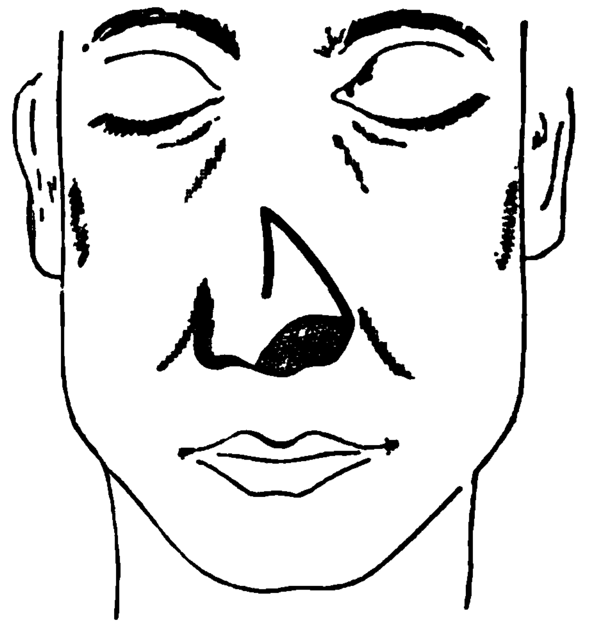
* It will be noted that Mr. Watson Cheyne's patient was a young adult, that the origin of the trouble was traumatic, and that there was no history of syphilis.

FIG. 128.



Rhinoplasty. Single lateral flap. (Stimson.)

FIG. 129.



Rhinoplasty. Denonvillers' method. (Stimson.)

In all the above methods, if cartilage is not included in the free border which is to form the new ala, the flaps should be cut long enough to allow of turning this border upon itself and thus giving a thicker and more natural appearance to it.

(δ) M. Weber's Method.—The flap is taken from the upper lip: on account of the hair follicles this plan is best suited to women. An oval flap is taken, usually from the centre of the lip, with its pedicle left attached close to the columna and its free margin reaching to the prolabium. The flap, which consists only of part of the thickness of the lip, is turned up, and stitched to the remains of the ala, which have been refreshed. The wound in the lip is closed or grafted. In three or four weeks this pedicle is divided, and may be so united to the inner surface of the flap as to give it a thicker and rounded margin.

ROUGE'S OPERATION.*

Indications.—Whenever the surgeon desires to gain free access to the nasal cavities, as in cases of—

1. Intractable ozæna.† Thus, when previous persevering treatment, including Thudichum's douche, fails to cure cases of strumous ozæna, with obstinate inspissated crusting of discharge under the turbinated bones; when dead bone is detected by a probe, or is believed to be

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* *Nouvelle Méthode pour le Traitement chirurgical de l'Ozène*, par le Dr. Rouge. Lausanne, 1873.

† Mr. Hayward (*Syst. of Surg.*, vol. ii. p. 644) believes that in a large number of cases of ozæna the discharge is due to a carious surface being present on the base of the skull. If this view is correct, it obviously points to not putting off this operation too late.

present in these cases, or, more commonly, in those of syphilitic ozæna. 2. In inveterately recurring nasal polypi, persisting after the steps advised at p. 368. 3. In some cases of naso-pharyngeal fibromata—viz., where the growth is small, and where a scar is especially deprecated.

Operation.—An anæsthetic having been administered, the surgeon must decide as to what steps he will take to prevent the blood from getting down into the pharynx. This may be done either by plugging the posterior nares, or by performing laryngotomy and plugging the fauces with a sponge (pp. 453, 480). If the hæmorrhage is likely to be troublesome, and the operation prolonged, I much prefer the latter precaution, for I have found that when the nostrils are plugged it is quite possible to sever the silk on one side, owing to its being hidden by clots, and its whereabouts thus not seen.*

The upper lip having been well raised and everted by an assistant taking hold of it at the angles of the mouth, the surgeon frees it from the upper jaw by an incision through the mucous membrane reaching from the bicuspid teeth on one side to their fellows. In doing this the knife should be kept close to the bones and parallel with them. The cartilaginous septum is next detached from the anterior nasal spine, and the lower lateral cartilages from the upper jaw, the adjacent parts of the cheek being also freed at the same time so as to admit of the nose and lips being lifted up sufficiently to explore the nasal cavities.

After any dead bone has been removed, the sharp spoon applied, and the nasal cavities thoroughly cleansed in cases of ozæna, or any polypi dealt with, the parts are replaced (without sutures), and the usual sterilised dressings or creolin fomentations applied until the pain and swelling have subsided, and the risk of erysipelas has gone by.

Other operations on the nose—*e.g.*, those of Lawrence and Ollier—are given later on under the heading of "Naso-pharyngeal Fibroma," p. 388.

REMOVAL OF NASAL POLYPI.

In cases where the use of the snare, aided by cocaine, while most successful in getting rid of the larger polypi, which make their appearance first, has proved tedious and inefficient in the case of the crops of the smaller ones, often sessile, which make their appearance later on, I recommend, very strongly, a trial of the subjoined method of Sir W. M. Banks. Having repeatedly made use of it, I have never found that the abundant hæmorrhage causes any serious trouble, as long as the assistant who administers the anæsthetic knows his business, and as long as the patient's head is kept on one side, over the edge of a table or sofa.

Sir W. M. Banks's method is given in his own words†:—

"As to the most permanently curative operation for nasal mucous polypi, I believe there is nothing equal to the use of the forceps properly managed. Where there are large isolated polypi with well-marked stalks, the wire snare or Dr. Thudichum's process may do well enough, and probably removes them with much less pain than the forceps. But these are not the most common cases. On the contrary, they are usually crops of small growths fringing the superior and middle turbinated bones, which no snare can get hold of, and which in due time make their appearance as large ones. Mr. Syme, after great experience, used to say that the only way was to get one blade of the forceps beneath the turbinated bone and the other on the opposite side of it, and to carry away as much bone as possible. This I always endeavour to do, and find that, along with the big ones, I have brought away whole crops of minute polypi just commencing their existence, which can only be removed by carrying away the bone from which they grow. As to necrosis and all sorts of contingencies which it is said *may* occur as a result of such rough surgery, the simple answer is, They don't occur. On the other hand, the patient has a chance of getting rid of the source of his trouble, and does not need to come every two or three years to have a fresh assault made upon a fresh lot. Failure often results from using forceps which are too big in the blades, and which are only toothed in the points instead of all the way down. In not a few cases where the patient has had several operations performed previously by other surgeons, I have simply smashed up the whole turbinated bone as widely as I could, and so have settled the matter permanently. Now the pain and dreadful sensations produced by this proceeding are more than mortals can bear, and so the patients have had chloroform or ether, and it would be an excellent thing if this were resorted to more frequently. Even a moderate assault with the forceps is a most horrid process, and patients who have gone through it once or twice will endure any amount of chronic misery rather than face it again. But only a very few surgeons seem inclined to give these unfortunates an anæsthetic, urging as their reason the danger of blood going down the throat and choking the patient, and the fact that, owing to the patient being insensible, he cannot blow down the nostrils so as to let it be known whether they are clear or not. My plan is to have the patient thoroughly anæsthetised on a sofa. When fully insensible his head should be brought over the edge so that the nostrils are dependent, and then the surgeon, kneeling on the floor, passes up the forceps, and pulls out everything he can until there is nothing to pull. Meantime, all the blood runs out of the nostrils, and none need go down the throat at all, while the whole time necessary for a thorough cleaning is about a minute for each nostril. I feel convinced that, for certain cases, the only satisfactory cure is to pull away as much as can be got of the superior and middle turbinated bones."

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* Plugging the fauces after a laryngotomy has the further advantage of leaving the posterior nares free for examination by a finger passed from the mouth, a point of importance in examining these parts, or in manipulations in the case of a polypus.

† *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 180.

From my own experience of this method I agree with every word of the above, and would add the following:—(1) The anæsthesia should not be pushed to abolition of the laryngeal reflex. (2) The points of the forceps should always be kept backwards parallel to the turbinated bones, not upwards to the base of the skull, or fatal mischief may easily be inflicted upon the delicate bones met with here. (3) A finger in the naso-pharynx, the mouth being opened by a gag, will often be of considerable service.

ADENOID GROWTHS OF THE NASO-PHARYNX.

Removal.—Here the first points that arise are the best *anæsthetic* and the most suitable *position of the patient.* Both points have been much debated.

Anæsthetic.—I have no hesitation in expressing my preference for ether, preceded when possible by gas,* in the majority of cases, *i.e.*, those of average severity, and I consider ether especially preferable when the anæsthetist is only of ordinary experience and skill. I am well aware of the objections which have been raised to ether here. In addition to the administration being more troublesome, the parts operated on are more vascular and swollen, the hæmorrhage is somewhat greater, and more mucus is present than is the case with chloroform. But I am equally assured that the advantages of ether outweigh the above disadvantages. Above all, it is safer than chloroform in hands of ordinary experience.† Where, in young and often feeble patients, elements of shock must be present—*e.g.*, hæmorrhage and interference with the respiratory passages—chloroform is always risky, and, unless given with much experience, may be most dangerous.‡ Ether enables any change in the patient's position to be safely made, and, if obstruction to respiration should take place, there is less risk of cardiac failure. With chloroform, cardiac failure may ensue at any time from the shock, from the hæmorrhage, from obstruction to respiration; from any needful sudden change in the patient's position; and, lastly, it may occur without any warning when the operation is over, and the effects of the anæsthetic seem to be safely passing off. Whatever anæsthetic is chosen, it should be pushed with care. Thus, while the corneal reflex should be abolished, that which governs coughing and swallowing should not be entirely removed.

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* In a *severer* case, or where the tonsils also are going to be removed, as soon as the patient is well under the influence of ether, chloroform may be substituted with advantage. On the other hand, in *slight* cases of adenoids, nitrous oxide gas followed by oxygen will give the operator sufficient time when the needful facilities are present for the above administration. I learnt the value of the above combination from Mr. Gardner (*Clin. Journ.*, Sept. 2, 1896). The above anæsthetist has found that the available anæsthesia is ten to fifteen seconds longer than that yielded by gas alone. He advises that, whenever the little patient will permit it, a small Hewitt's prop should be inserted between the teeth before the mouthpiece is applied, in order to facilitate the introduction of a Mason's gag at the height of anæsthesia. It must be remembered that it is only in *slight* cases that gas and oxygen will suffice. With this limited anæsthesia there must be a tendency to hurry, and thus a risk of an imperfect operation. I strongly advise operators whose experience is limited to avail themselves of the longer anæsthesia of ether, however slight the case may seem to be.

† I desire that here, as throughout my book, it should be remembered I am only writing for the benefit of my junior brethren, and in view of the conditions under which they are, of necessity, often placed.

‡ That sound and careful surgeon, Mr. Waterhouse (*Clin. Journ.*, 1896, p. 281), while preferring chloroform to ether, writes of chloroform as follows:—"There have, however, been, even in careful hands, so many deaths from this anæsthetic during the removal of adenoids, that we must admit that its administration is by no means without a certain element of risk. I have used it hundreds of times, but always with fear and trembling, which, by the way, is not an unwise precaution when dealing with this powerful and dangerous drug."

Position.—This again has been much debated. I shall refer to a choice of three positions. I much prefer the first

1. The patient lies on the right side, with the head somewhat raised, and bent a little forwards over the edge of a table of appropriate height.

2. The patient, under ether, is propped up in the sitting position, with the head and shoulders thrown well forwards, and the face looking downwards into a basin placed between the patient's knees. This position is only justifiable with ether. It is an excellent one from the anæsthetist's point of view, owing to the facility and safety with which blood escapes from the mouth. It is not quite so convenient to the operator. We owe it to Mr. Braine.

3. The patient lies on his back, with the shoulders a little raised, and the head thrown back and hanging over the end of the table. In this position the head is supported by an assistant or nurse. This is the same position as that used in cleft palate operations. "It answers admirably for both operations, as the blood thus falls down into the pharyngeal dome, and wells up through the anterior nares,[*] leaving the lower air-way free and open. . . . . I do not think that this lowered position of the head adds materially to the amount of bleeding" (Owen's *Surgical Diseases of Children*, third ed., p. 208).

Operation.—We will suppose the patient to be in the first of the above given positions. One of Hewitt's modified Mason's gags is inserted[†] and securely held, as widely opened as possible, on the left side. An assistant should be ready with clean sponges, as large as are admissible, firmly fixed on holders or forceps, to sponge out blood rapidly and efficiently from the right cheek and side of the mouth. The removal of the adenoids is now effected with the nail, the artificial nail, a curette, or forceps. (1) *The Natural Nail.*—The advantages of this are obvious; it is simple, it takes up a minimum of room, and its natural sensitiveness is a great aid to the operator in detecting the position and extent of the growths. It has been objected to as insufficient, and as leading to the need of repeated operations. This may be due to want of care. The finger-nail must be long enough, but not too long or brittle so as to bend or break. It must only be used for those cases (the commonest) where the adenoids are soft; in the much rarer ones, firmer and harder, met with sometimes in older patients, either the curette or forceps should be used. If the finger-nail be used with proper precautions, and employed thoroughly, I believe it to be entirely efficient in the majority of cases. In a naso-pharynx blocked up with adenoids, the finger introduced behind the soft palate should first make out the septum and outline of the posterior nares, and clear these thoroughly; next, pressed upwards into the vault of the naso-pharynx, it is drawn firmly backwards and downwards several times, first in the middle line and then laterally, care being taken as the orifices of the Eustachian tubes are approached. The adenoids thus removed are partly expelled with the blood through the nose, partly mopped up, and some swallowed. (2) *The Artificial Nail.*—This has some advantages over the ordinary nail: it does not break or bend, and it penetrates more deeply. Its disadvantages are the impairment of tactile sensibility and the increase of bulk which it entails; the latter a point of importance in a little child. (3) *Curettes.*—The best of these are Gottstein's and Golding Bird's modification of it. The latter, in my opinion, reaches better than any other curette those adenoids situated high up at the junction of the roof and back of the naso-pharynx. The fenestra of the curette having been guided into the naso-pharynx by a forefinger, is passed quite up into the vault; then, the handle being held firmly, the curette is pressed well down upon the roof of the pharynx, and drawn backwards and downwards so that its sharp edge is made to sever all the vegetations in its sweep. This is repeated according to the severity of the case and the results found by the finger, but the lateral aspects of the naso-pharynx, especially the vicinity of the Eustachian tubes, should be carefully avoided by the curette. Here, as in the regions curetted, the finger-nail should complete the work. In buying a curette the surgeon should remember that instrument-makers often turn out these (and Lowenberg's forceps also) monstrously large for the naso-pharynx of a little child. (4) *Lowenberg's Forceps.*—These are only required when the adenoids are firm and fibrous and tough, being quite unnecessary in the soft vascular adenoids usually met with in early life. It sounds easy enough to introduce the forceps, guided by the finger, into the naso-pharynx, push them up to the roof, and then to press them into the adenoid masses, out of which, by a combined punching out, twisting, and tearing, the growths are pulled away, or, in cases of really firm adenoids, pieces punched out until the rest can be removed by the curette or finger-nail. But practically it will not be found easy, in the naso-pharynx of a child, to simultaneously accommodate both finger and forceps, and to manipulate the forceps with the necessary freedom. And unless the blades are accurately guided by the finger it is easy to seize and bruise the septum (especially when the head is in the dependent position) and to tear away strips of mucous membrane. Very grave hæmorrhage has also followed the use of the forceps. The forceps usually sold by instrument-makers are absurdly large for children, in whom a great proportion of post-nasal growths occur. The best forms are those of Symonds and St. Clair Thomson's modification of the Jurasz-Lowenberg's forceps (*Brit. Med. Journ.*, vol. i. 1898, p. 632). These forceps are particularly light and short, making it easier to use the finger at the same time. With these and all modifications of Lowenberg's forceps opening laterally, care must be taken not to damage the orifices of the Eustachian tubes.

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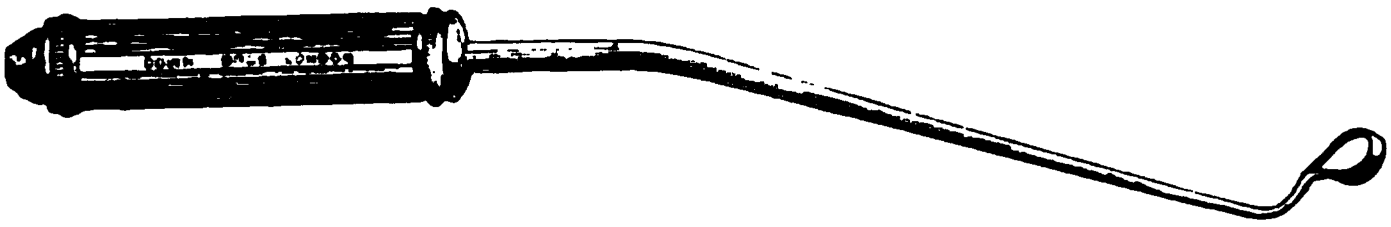
[*] But if, as often happens in these ill-developed patients, "nasal obstruction is present even in a minor degree, this position is not a good one for the escape of blood" (Hewitt, *Anæsthetics and their Administration*, p. 37).

Care must be taken now with any loose or decayed teeth.

FIG. 130.



Golding Bird's curette. (Down Bros.' Cat.)

After-treatment.—The patient should be kept on one side for some time after the operation, and carefully watched, especially on account of the vomiting of blood, which is almost certain to follow. The hæmorrhage, severe at the time, soon ceases, and very rarely causes anxiety a few hours later. In such cases, syringing hot water through the anterior nares, the patient being in the position I have already advocated, or a gauze tampon (secured by silk) passed into the naso-pharynx with a pair of forceps, must be tried. The child, if delicate, should be kept in bed for two or three days, and in damp or wet weather should not leave the house for a week. As a rule, especially in little children, where the parts are so small and delicate, the use of the syringe or Politzer's bag is to be deferred until sufficient time has elapsed to show the result of the operation The friends should be prepared for the breathing being even worse than usual for the first two or three days. Improvement, especially in the gain in nose-breathing, begins from the fourth to the seventh day. The atrophy of any remaining adenoids will be promoted by the practice of nose-breathing, the child being made to sit quiet for ten minutes four times a day, and breathe through the nose alone. All possible pains must be taken to improve the general health, especially in the cases where tuberculosis or congenital syphilis is present.

Complications and Sequelæ.—1 and 2. Hæmorrhage and Shock.—I have already spoken of these, and would here again remind my readers that, in addition to deaths under chloroform, there have been fatal results from hæmorrhage. While this complication, not owning any arterial source, usually quickly ceases of itself, and, when severer, yields to plugging of the naso-pharynx with gauze wrung out of turpentine, a solution of iron nitrate, matico, &c., fatal cases have undoubtedly occurred both at the time and a few hours later. In a few this result may have been due to hæmophilia; in others, from the accidental tearing off of pharyngeal mucous membrane, or direct injury to a large blood-vessel (Newcomb), both these accidents being more likely to occur with Lowenberg's forceps, according to the advocates of Gottstein's curett Dr. Newcomb candidly publishes (*Amer. Journ. Med. Sci.*, 1893, vol. cv. p. 574) a case in which death took place from hæmorrhage sixte hours after the operation. While, as medical aid was not summoned unt this time had elapsed, no blame whatever can attach to the operat the case shows the importance of keeping these patients under observ-tion for twenty-four hours.* 3. Broncho-pneumonia from the entran of blood into the lungs. 4. Sepsis 5. Ear Trouble. In a few cas pain in the ears is complained of, probably due to entrance of blo into the tympanum along the Eustachian tube. Another rare and m serious aural complication is otitis media from injury to the Eustach tube, the introduction of sepsis, or unwise use of the nasal douche. If deafness was present before the operation and has not improved ten days after, Politzer's process with the application of astringents to the naso-pharynx will be indicated. 6. It is not very uncommon for some of the cervical glands to become painful and swollen, but, unless sepsis has been introduced or the patient's vitality is very low, suppuration does not follow. 7. Exanthemata.—Mr. Sheild (*Diseases of the Ear*, p. 213) calls attention to the importance of the operation-wound not being exposed to the virus of scarlet fever, diphtheria, or sewer-gas. 8. Question of Recurrence.—This is stated by some to be common. I have found it distinctly rare myself, when the operation has been properly performed, though parents are liable to take several conditions which may co-exist with adenoids for the recurrence of the adenoids themselves. Recurrence or, more correctly, persistence of adenoids is not uncommon when the operation has been done "against time," either for show, or because the operator has been nervous about the anæsthetic. Where an inefficient finger-nail has been solely employed, or where the finger-nail has been used in cases which call for the curette—*e.g.*, the more fibrous, tough processes, either tongue-like, or sessile and ridged, which are met with in older patients,—in such cases persistence will follow. If the adenoids have been properly dealt with, and mouth-breathing persist, some other cause must be sought for. Very likely nose-breathing has not been assiduously practised; or some such condition as enlarged tonsils, deviation of the septum, enlargement of the posterior extremities of the turbinals, or hypertrophic rhinitis may be present and require attention. All such conditions should have been detected at the time of the first anæsthetic, and, if not dealt with then, the patient's friends should have been made aware that more would require to be done.

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* Dr. Newcomb refers to a case, reported by Hooper, where a digital examination hæmophilic subject caused a fatal hæmorrhage. He also alludes to two other fa cases, recorded by Dr. Delavan (*Trans Amer Laryngol Assoc.*, 1892, and *New York M Journ* Nov. 19 1892) He warns against operating on patients approaching the time menstruation, and those in whom there has been any recent inf Dr Preble has recorded a case in which secondary hæmorrh day, the patient, æt. 11, fainting It recurred, and wa posterior nares. On the eighth day a sudden gush to before assistance could be given. There was no h has collected twenty-one cases of serious prima fatal, and five of secondary hæmorrhage.

CHAPTER VII.

OPERATIONS ON THE JAWS.

OPERATIONS ON THE UPPER JAW.

THESE will include—

i. Removal, partial or complete, for growths (Figs. 131, 132).
ii. Operations for naso-pharyngeal fibroma (Figs. 133 to 137).
iii. Opening the antrum.

REMOVAL OF THE UPPER JAW, PARTIAL OR COMPLETE.

Indications.—These include the different growths to which the upper jaw is liable, and opportunity will be taken here to give briefly the chief practical points in connection with these.

1. Epulis.—One of the new growths most frequently met with here. Etymologically gum tumours, these growths vary a good deal. At first, and most frequently, they are simply fibrous, tough and firm, springing from the periosteum, the periodontal membrane, and the endosteal lining of an alveolus. Myeloid cells and small spicules of bone are not uncommon. The longer they are left, the more they are irritated. especially with imperfect attempts at removal, the more cellular and sarcomatous do they become.

Very rarely on drawing the tooth, to the alveolus of which the growth is connected, the epulis comes away completely. Much more frequently it is firmly connected to the periosteum and subjacent cancellous tissue, or to the endosteal lining of one or more alveoli. Removal should be early and complete. Shaving off the growth and the gum beneath, and then applying caustics to any suspicious granulations, is most uncertain and unsatisfactory, especially if the presence of teeth be allowed to interfere with the complete removal of the growth, or if this be connected with stumps, and thus dip deeply into an alveolus. By far the best treatment is to draw a tooth in front and another behind the growth, and then with a narrow saw to notch the bone at these points deeply through the alveoli: with cutting-forceps, or better, a chisel and mallet, a V-shaped or rectangular piece of the bone is then removed. The drawing of teeth not only enables the surgeon thoroughly to eradicate the growth, but their removal leads, as pointed out by Mr. Salter,* to wasting of the alveolus, and thus to non-recurrence of the growth. The teeth, if sound, should be preserved, and, later on, when all is firmly healed, fitted to a plate by a dentist. The deformity is thus rendered imperceptible.

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* *System of Surgery*, vol. ii. p. 456. Mr. Salter also points out that where an epulis forms on an apparently edentulous part of the jaw, the existence of stumps should always be looked for.

In 1884, a captain in the Royal Navy, whose ship was on the North American station, came under my care with an epulis of the lower incisors and contiguous alveolar margin. The teeth were all preserved, and, when the parts were soundly healed, Mr. Moon refitted them so skilfully that no trace whatever of an operation could be noticed, and the use of a speaking-trumpet, which was most essential in this case, was not interfered with.

If a patient refuses the only operation which is safe, the surgeon must rest satisfied with shaving off the growth, gouging the subjacent bone, and, if needful, applying caustics to any suspicious patches later on. This course is not only much more tedious and painful, but is uncertain to boot.

2. Fibroma.—These originate either in the periosteum or in the endosteum of the antrum. At first firm, dense, and slow-growing, they may, from the frequent irritation inseparable from their site, become vascular, sloughy, and, taking on more rapid growth, tend to invade the numerous fossæ, fissures, and foramina in the neighbourhood of the bone. They should be attacked early; and while the surgeon may need at this stage to remove only the periosteum and bone from which the tumour springs, especially if it be alveolar in origin, or after opening the antrum to shell out the fibroma completely, he must also be prepared for more radical measures, *e.g.*, when the growth is of long standing, of late more rapid, if the patient is at all advanced in years, and especially if the growth is recurrent.

3. Sarcoma.—These include the spindle, round, and myeloid varieties, the fibro-, chondro-, and osteo-sarcomata, and the rarer form of alveolar sarcoma. While the more slowly growing ones simulate more innocent growths such as epulis, the more rapid ones will tax the surgeon's judgment as to whether any operation is justifiable, and all his skill if removal be attempted. On these subjects the reader is referred to p. 378.

4. Carcinomata.—At the present time the softer growths which attack the jaw, and were formerly called medullary cancers, are looked upon as rapidly growing sarcomata. The only true carcinomata met with here are epitheliomata. These are usually of the squamous kind, and commence in the alveolar border in ulceration, beginning in syphilis or the irritation of an ill-fitting tooth-plate. They tend to creep far back and to invade the palate and tonsil; on this account they should be operated on early. Whenever a sore in this position is suspicious in its characters, and obstinate to treatment, whatever be the age of the patient, the parts affected should be widely and freely extirpated. If the growth has eaten into the antrum or has travelled back so as to invade the pterygoid region, removal of the whole bone is most likely to benefit the patient. More rarely a squamous epithelioma attacks the jaw from the lip or face. This happens much more often in the case of the lower jaw. Another epithelioma met with here is the tubular* variety (cylindrical or adenoid carcinoma), which begins in the mucous membrane of

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* Mr. Heath (*Dict. of Surg.*, vol. i. p. 857) quotes Réclus as calling this form *epithélioma térébrant*, from its boring or burrowing tendency.

the antrum or nose. It is marked by rapidity of growth and invasion of the surrounding parts, and is thus of grave prognosis.

5. Dentigerous Cysts.—These are formed by a collection of serous fluid taking place during the development of a tooth, nearly always a permanent one, which has not come through the bone.*

There are two varieties of these cysts; one, the commonest, is cystic only, consisting of an outer bony shell of varying thickness, and an inner membranous one. The tooth may be well formed, or a small, shapeless, calcified mass; its crown usually projects into the sac, vertically or horizontally.

The following points are of practical importance. These cystic swellings may be taken for solid growths, but this mistake may be avoided by remembering that when such a swelling exists there is usually a history of its having commenced in early life, and that though all the teeth may appear to be present, one will very likely be found to be a temporary one. Furthermore, there is the help derived from puncture with a fine trocar.†

The treatment consists in exposing the surface of the cyst by turning the lip up, or by making incisions through this as small as possible, then cutting away freely (with bone-forceps aided by a ¾-inch trephine if needful) the walls of the cyst‡ so as to examine its contents, and digging out the tooth—often the most difficult part of the operation. The cavity is then carefully stuffed with strips of aseptic gauze to encourage its granulating from the bottom. If any swelling persist, keeping up deformity, pressure must be trusted to, a Hainsby's truss being here found useful.

In the other variety of dentigerous cysts, solid growth of a sarcomatous nature is present in addition to the cystic. The surgeon here must use his discretion as to opening the cyst, freely scraping out the growth and then applying the cautery or zinc chloride paste (p. 339), or removing the bone itself. If the case is of any duration, if the growth is soft and making rapid progress, the latter course will be the wiser one.

6. Enchondromata.—These are rare. They seem to commence in adolescence, usually starting from one surface of the bone—*e.g.*, the nasal, or from the antrum. They should be removed early and completely, as they grow steadily, involving the nose, orbit, frontal sinuses, and thinning the cranial bones.§

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* Mr. Salter (*Syst. of Surg.*, vol. ii. p. 469) gives the following three circumstances as capable of producing impaction of a tooth:—(1) The tooth may be originally developed too deep in the body of the jaw—thus, though it grow in the right direction, it will never reach the alveolar margin; (2) while it may be sufficiently superficial, it takes an oblique direction of growth, so that it lies covered more or less in the axis of the bone; (3) the position of the tooth and its line of growth may be originally normal, but from arrest of the development of the fang it may fail to reach the alveolar edge.

† Mr. Fearn, of Derby, was candid enough to publish an instance of this mistake in diagnosis in the case of the lower jaw, *Brit. Med. Journ.*, Aug. 27, 1864. The specimen is figured in Mr. Heath's *Injuries and Diseases of the Jaws*, p. 162, and shows well how such a mistake might have arisen.

‡ A good illustration will be found in Mr. Bryant's *Surgery*, vol. i. Fig. 194.

§ Good instances of what these enchondromata may come to are given by Mr. Morgan's case, *Guy's Hosp. Rep.*, 1842; Mr. Heath's *Injuries and Diseases of the Jaws*, p. 237, with an excellent illustration, Fig. 107.

7. Osteomata.—These are rare also. Two forms occur: (1) of the nature of an ordinary exostosis. These are usually cancellous, but ivory ones arise from the superior maxilla as well as from the orbit and frontal sinuses. Occasionally they are symmetrical.* Their growth is usually slow. If they occur in young subjects they should be attacked while small. The ivory exostoses are occasionally found loose on laying open the antrum, as is the case with those in the frontal sinuses. (2) Diffuse osteomata. These are intermediate in hardness between cancellous and ivory exostoses. They have often broad, ill-defined bases, and are not infrequently multiple and symmetrical. As they tend to produce hideous deformity, and though slowly, most distressingly, to destroy life, they should be attacked while small. Mr. Pollock† quotes Mr. Stanley‡ as an authority for the fact that in cases where the whole mass is beyond removal, a portion may be cut away with present, if not permanent, benefit. This can only apply to osteomata of purely hypertrophic nature. Where the bony growth is tipped with cartilage every atom must be removed for the operation to be of any benefit. Well-made osteotomes and drills worked by a dentist's instrument may be of much service here, the great object being to drill a number of holes in different directions through the growth, and then to cut through the intervening bone with osteotomes and a mallet. One of the chief risks is that of intracranial inflammation, especially if the growth has involved the interior of the skull.

8. Odontomes.—These are very rare, and usually occur in the lower jaw. They are liable to be mistaken for osteomata or necrosis with anomalous symptoms, as in one occurring in the upper jaw, recorded by Mr. Jordan Lloyd (*Lancet*, 1888, vol. i. p. 64; Bland Sutton, *Trans. Odont. Soc.*, Nov. 1887).

Questions arising before attempting the Removal of the Upper Jaw.

(i.) Is the growth cystic or solid? (ii.) What is the relation of the growth to the jaw? Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw? (iii.) Is the growth one, whether malignant or not, that it is wise to attempt to remove?

(i.) **Is the Growth Cystic or Solid?**—Mr. Fearn's case, already quoted at p. 376, shows that mistakes may arise here. Mr. Heath gives a case under his own care in which caseous pus, after suppuration in the antrum, was taken for a solid growth, and the jaw removed. As the diagnosis is evidently most difficult in some cases, the surgeon should, in all cases of doubt, explore first with a trocar and cannula, or a drill or bradawl.

(ii.) **What is the Relation of the Growth to the Jaw?**—Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw?

In some cases it is quite impossible to be sure on this point up to the time when the flaps are reflected or till the jaw itself is removed; even the use of a finger aided by an anæsthetic is insufficient.

The following points may be useful in aiding a decision as to the relation of the growth to the jaw:—

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* In Mr. Hutchinson's *Clinical Surgery*, vol. i. p. 11, Figs. 3, 4 will be found admirable illustrations of symmetrical exostoses from the upper jaw.

† *Syst. of Surg.*, vol. ii. p. 535.

‡ *Diseases of Bones*, p. 5.

If the growth began on the surface of the jaw—*e.g.*, the nasal or malar process—there will probably be a history of a lump noticed here first, very likely after a blow, and any evidence of the antrum, nose, palate, and orbit being involved will be deferred till late. On lifting up the cheek, masses of growth will very probably be found creeping down between the cheek and gums, but not altering the line or affecting the structure of the alveolus, unless it commenced in it or just above it.

If the growth began in the antrum, the cheek is more slowly swollen, and the swelling is deeper and less defined. The different walls and boundaries of the cavities—viz., the orbital, nasal, facial, and zygomatic—are expanded steadily and with a varying rapidity, while the palate is depressed, the alveolar border displaced, and the teeth rendered irregular.

If the growth began behind the antrum—*e.g.*, in the basilar process of the sphenoid or the pterygo-maxillary fossa—in many cases a history will be given of polypi removed from the nose or pharynx some time before, perhaps recurring soon; the upper jaw is pushed forwards, and in some cases there is but little alteration in its outward shape, but this is by no means constant. Not unfrequently the upper jaw will be so altered by pressure, its processes—*e.g.*, the malar—so thinned, flattened, and expanded, that it may well be thought that the disease began in the bone itself. And this mistake is the more excusable when it is remembered how easily a growth situated behind the antrum may make its way into this cavity, either by absorbing its walls, or by entering it through the opening into the nose.

If the growth has begun behind the antrum, starting from the base of the skull, symptoms pointing to blocking of the nose—viz., pain here, in the orbit and brow; epiphora from blocking of the nasal duct; interference with nasal breathing, epistaxis, &c.—will most probably be present, yet it must be remembered that many of these symptoms will be brought about by a growth within the antrum increasing rapidly.

It is only, I think, when the surgeon finds no evidence of the growth beneath the skin, or of its originating on the surface of the bone, no depression of the palate, and no irregularity of the alveolar margin or displacement of the teeth, that he can say that the growth is probably behind the antrum.

(iii.) **Is the Growth one, whether Malignant or not, that it is wise to attempt to Remove?**—While every case must be decided upon separately, and while it would be most misleading to lay down hard-and-fast rules, the following are not unworthy of attention:—

Favourable Cases.—Growths with a duration extending over many months, hard, well defined, limited to the jaw, with the skin over the growth perhaps thinned from pressure and altered in colour, but still movable over the parts beneath.

Unfavourable Cases.—History of a few months' duration; growth soft, vascular, ill defined; integuments involved and fixed; naso-pharynx invaded; extension into orbit or temple—*e.g.*, a soft, semi-elastic swelling noticed behind the malar bone in the temporal region; extension to the sub-maxillary and cervical glands; origin of the growth behind the jaw, rather than on it.

Occasionally, a growth, unfavourable at first sight from its large size, will be found to have protruded on to the face without involving the parts around, and especially those behind.

The history must be carefully examined into. If it be doubtful where the growth began, whether it has invaded or only crept towards the nostril, the surgeon will inquire as to the existence of deep-seated pain, stuffiness in the back of the nose, loss of smell, interference with nasal respiration, epistaxis, &c. Again, the existence of any swelling near the inner canthus will point to extension towards the ethmoid and base of the skull.

Complete Removal of Upper Jaw (Figs. 131 and 132).—The patient having been brought carefully* under an anæsthetic, and duly propped up, the face shaved, and the head raised and turned over towards the opposite side, the surgeon takes this opportunity of examining more completely the attachments and limits of the growth, and decides whether, owing to its vascularity, it will be wiser to perform a preliminary laryngotomy and plug the back of the pharynx, or to place a temporary ligature on the carotid (*q.v.*).

The incision, which goes by the name of Sir W. Fergusson,† is then made through the centre of the lower lip (an assistant controlling the opposite coronary while the one in the flap is commanded by the surgeon himself), round the ala, up along the side of the nose to the inner canthus, and outwards just below the margin of the orbit, as far as the malar prominence. The flap thus marked out is then reflected, and wrapped in sterilised gauze. Though no large vessels are cut, the hæmorrhage is often free, especially in cases of rapidly growing tumours which have thinned the bone. Spencer Wells's forceps are applied to the larger of the vessels; while the flap is being reflected these are secured, and an assistant makes pressure, if needful, upon the flap to arrest oozing, while the surgeon divides the bones in the following order, the ala of the nose being first detached from the bony margin, and the periosteum of the floor of the orbit freed:

(1) The junction of the jaw with the malar bone is divided. The line for the saw is marked out with the knife upon the bone just in front of the origin of the masseter. With a narrow strong-backed saw (Fergusson's or Adams' osteotomy-saw) this line is converted into a deep groove and the rest of the bone quickly severed with forceps, the left forefinger placed upon the margin of the orbit steadying these instruments and preventing any damage to the eye. This bone section is practically in a line with the spheno-maxillary fissure (at the lower

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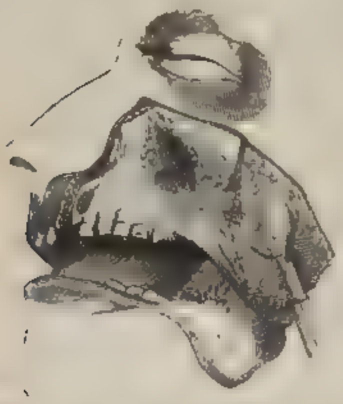
* As in excision of the tongue, the assistant to whom the anæsthetic is entrusted is second only in importance to the surgeon. He should watch most carefully for the first signs of flagging of the pulse, and meet this by injections of ether or brandy. Any evidence of blood going down the throat, dyspnœa (as shown by venous stasis of the cheeks), lividity of the lips, or respiration short and fixed, must also be looked out for. The patient should be brought thoroughly under the influence of the anæsthetic to begin with, and the degree of anæsthesia maintained should abolish the corneal but not the laryngeal reflex.

† First recommended by Dieffenbach. Its advantages are very great—viz., (1) only the terminal branches of the facial nerve are divided; (2) only branches of the facial vessels, not their trunks, are cut; (3) the scar left is much less conspicuous, as the incisions are placed in the natural feature-folds.

and outer part of the orbit), and should fall into it. This will preserve the prominence of the cheek. If the malar bone be involved the zygoma must be sawn through.

(2) The nasal process of the superior maxilla is next severed by cutting a saw-groove across it, and then placing one blade of the forceps inside the nostril and the other against the inner angle of the orbit the soft parts being first a little freed and carefully kept out of the way with the left thumb-nail.

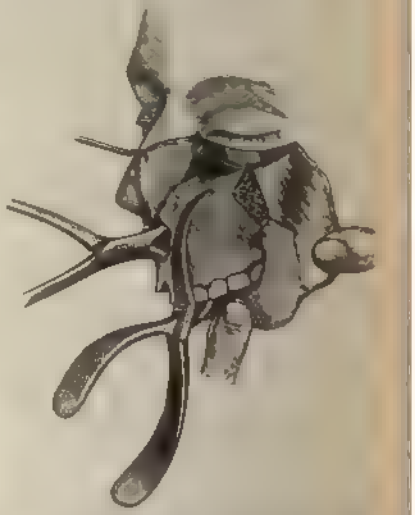
FIG. 131.



Removal of upper jaw (Earlier stage Reflection of the flap, and section of the bones

(3) The central or a lateral incisor being next drawn, the mouth is widely opened with a gag, an incision made with a stout scalpel along the middle line of the hard palate up to the teeth, and another transversely outwards at the junction of the hard and soft palate, towards the molar teeth on the side affected The soft palate is then detached with a scalpel or blunt-pointed scissors, and thus preserved when the bone and growth are wrenched away. The hard palate is next deeply notched with the saw introduced through the nose opposite to the tooth which has been drawn, and severed with bone-forceps, one blade of which is introduced within the nose, the other into the mouth. If a chisel or osteotome be now inserted into the different lines of bone section, the bone is loosened with a series of quick and careful levering movements, while, finally, lion-forceps being made to bite firmly into the hard palate and the malar aspect of the bone, in the manner shown in Fig. 132, the bone is detached by a few wrenching, rocking movements upwards and downwards and laterally, the left forefinger detaching any soft parts which retain the bone, and the superior maxillary nerve being cut cleanly with scissors.

FIG. 132.



Removal of upper jaw. (Later stage) The flaps are reflected and held aside The bones have been divided The upper jaw is being disarticulated with the lion forceps while a pair of cutting bone-forceps completes the division of the palatine attachments Heath.

When the bone has been much invaded by disease, or in the case of an aged dead body, it is very likely to come away in fragments, being unavoidably crushed down by the forceps.

On the removal of the bone, the pterygoid fossæ, the cavity of the nose, and the palate are examined, the sharp spoon being applied to remove any remaining portions of disease, or Paquelin's cautery or pure formalin made use of to destroy what cannot be otherwise removed.

The bleeding is seldom free at this stage, save in rapidly growing cases, as the branches of the internal maxillary are small before they reach the tumour, and, as they are torn through, it is usually arrested by firm sponge-pressure.

If there is any doubt about a part of the growth having been left behind, some paste of zinc chloride, made up with equal parts of flour, had best be inserted on gauze to which silk is attached, the threads being brought out of the mouth through the palate, and so readily removed after a few days (p. 339). But if the bone has come away with all the growth, if the surface of this is smooth and encapsuled, not ragged or lacerated, the surgeon will do best to insert nothing into the cavity. If oozing is going on, or if there is reason to fear intermediary hæmorrhage, strips of iodoform or sal alembroth gauze should be carefully packed in, and removed later on by the mouth. But it is difficult to keep even these sweet, and the surgeon will do best to dispense with any plugging if possible, and to content himself with brushing over the wound with a solution of zinc chloride (gr. xx.–℥j.), or with a solution of iodoform in ether. The edges of the wound are then brought together with a few points of salmon-gut or silver-wire suture, one or two of these being always inserted in the lip, and others of horsehair. Especial care should be paid to adjusting the red line. A few strips of iodoform gauze sterilised in carbolic acid are then laid along the line of incision, with transverse ones across the divided lip, so as to give additional support here; they are kept in position with iodoform and collodion sterilised by heat.

During the after-treatment the patient should be kept well propped up to facilitate the escape of discharges, which must be prevented from collecting by frequent syringing, or, what is better, by the patient himself often rinsing and gargling his mouth and wound with some safe antiseptic solution, *e.g.*, potassium-permanganate lotion, or one of spirit of wine, ℥ss. to a tumbler of water. The wound inside should be, if needful, occasionally brushed over with iodoform in ether (1 in 8). If needful, the patient should be fed with a soft tube for the first few days.

In those cases, rare nowadays, where the growth is of great size, owing to the operation being deferred, the mouth may remain open for some days after, but the power over the muscles which raise the lower jaw is gradually regained. The lost sensation is usually restored, and the resulting deformity is often very slight.* Later on, when the parts are soundly healed, the skill of a dentist is called in to fit on a tooth-plate,† and obturator if needful.

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* No skin is, of course, removed, even if it appears to be very redundant; it rarely sloughs, save when the stretching has been extreme, or when it has been needful to apply the cautery to the flap. When the growth has invaded the skin over it, a hideous fistula is left, which must be closed later on, if the patient survives, which he seldom does in these cases.

† Mr. Butcher (*loc. supra cit.*, p. 270) in one case preserved the last molar tooth and part of the tuberosity as a fixed point for a tooth-plate, intending to have removed this if the disease recurred in it subsequently.

Partial Extirpation of the Upper Jaw.—Operations for removal of an epulis with the alveolar border have been described at p. 374, and one for opening up and exploring the antrum is given at p. 394.

If the surgeon find that the lower part only of the upper jaw need be removed, abundant room will be given by dividing the upper lip in the middle line, prolonging this round the columella into the nostril on the diseased side. By detaching the nose and dissecting up the flap of cheek the facial surface of the jaw can be well exposed.

Again, if, after exposing the whole jaw by Sir W. Fergusson's incision, the surgeon find that the orbital plate can be spared, a horizontal saw-cut is made just below the infra-orbital foramen, and the bone cut through with a chisel and a few taps of a mallet.*

When the orbital and nasal parts of the upper jaw are involved and the lower alveolar portions are sound, these latter may be thus preserved. A cheek flap being reflected by an incision through the lip and upwards to the inner canthus along the nose, the nasal and malar processes are divided while the eye is duly protected. A horizontal saw-cut is then made above the alveolar process, outwards from the nose, and another carried upwards from the outer end of this, to join the incision through the malar process, being made either with the saw or chisel. The piece of bone thus mapped out is loosened with a chisel or elevator, and either prised out with the latter instrument, or wrenched downwards and outwards with the lion-forceps.

Several other operations involving partial removal of the upper jaw are given under the Treatment of Naso-pharyngeal Fibroma (p. 390).

Difficulties and Dangers during the Operation.—These have been already alluded to: the chief are—

1. Shock.
2. Hæmorrhage.
3. Breaking down of the bone in the lion-forceps.
4. Outlying pieces of growth either in the pterygoid or other fossæ or in the temporal region, or far back in the roof of the nose.

Possible Causes of Failure.

1. Prolonged shock. Inability to rally. Besides the usual application of warmth and injections of ether and brandy, feeding with nutrient enemata or through a tube passed by the mouth or by the opposite nostril should be early resorted to, especially in the case of elderly patients, or in those much run down.

2. Secondary hæmorrhage. If this be severe, resisting the use of ice &c., the wound must be opened up, and, if no definite bleeding point be found, firm plugging must be resorted to, either with iodoform gauze wrung out of carbolic acid lotion (1 in 20) and dusted with iodoform, or the same, with the ends in the wound, wrung out of turpentine. These steps failing to arrest the hæmorrhage, ligature of the common or the external carotid must be employed.

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* The orbital plate should always be left, if possible. As Mr. Butlin (*loc. supra cit.* p. 134) points out, when the floor of the orbit has been removed there often results only serious disfigurement, but much œdema of the lower lid, and an unhealthy condition of the eye itself, which may be destroyed. Paralysis of the lower part of the orbicularis and epiphora from damage to the lachrymal duct are, also, not uncommon sequelæ.

3. Cellulitis and erysipelas. These grave complications are likely to set in when the patient is aged or much broken down in health, with impaired viscera, or when, owing to extensive removal of bone—*e.g.*, having to saw through the zygoma and loosen the outer wall of the orbit—the surgeon opens up deep planes of cellular tissue, which cannot, from the surroundings, be kept aseptic, most troublesome burrowing in the neck probably following. To cut cellulitis short, free scarification with small incisions should be made use of early so as to unload the parts, and abscesses should be opened at once.

4. Lung trouble. Broncho-pneumonia from inhaling septic matter is here, as after removal of the tongue, a decided risk. In this case, also, the treatment is mainly preventive, every endeavour being used to keep the wound sweet by the means already given (p. 381).

5. Inflammation of the brain or its membranes.

Mr. Butlin (*loc. supra cit.*) has shown that the mortality after removal of the upper jaw is nearly 30 per cent.—a large mortality, equal to that of amputation of the thigh in the upper half (for disease), or perhaps exceeding it. He goes on to remark that, if we are to reduce this mortality, "we must adopt two courses in the after-treatment—first, such means as will render the wounds aseptic; second, regular and sufficient administration of food."

6. Recurrence.

With regard to this, Mr. Butlin considers the prospect as very gloomy, only four cases out of sixty-four (in which the result is recorded) being able to be considered successful—*i.e.*, having remained cured for three years.

OPERATIONS FOR NASO-PHARYNGEAL FIBROMA* AND NASAL SARCOMATA

(Figs. 133 to 137).

Attachments and Relations.—The surgeon should consider these carefully before deciding what operation he will adopt for one of these most dangerous growths.

They will vary according to the duration of the fibroma. The primary attachments of the growth start by far most frequently from the base of the skull, arising in the thick periosteum invested by mucous membrane which covers in the roof of the nose and top of the pharynx, especially the adjacent parts of the basi-sphenoid and basi-occipital. Less frequently they may arise in the pterygoid fossa and adjacent plates, or from around the posterior nares. Dr. Sands† points out that the region in which a naso-pharyngeal fibroma can originate is one of narrow limits, corresponding with the margins of the posterior nares and the summit of the pharynx. It is thus one that can be satisfactorily explored with the finger, and by this means a growth should be detected in its early stage and removed safely while yet small.

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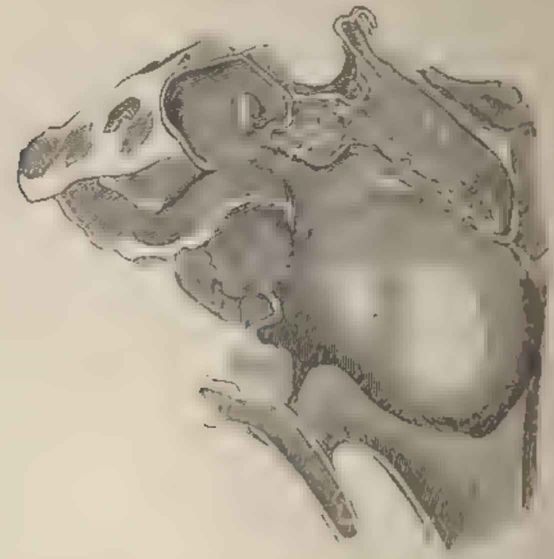
* The usual name, "naso-pharyngeal polypus," should be abandoned. It is inaccurate. Anything like a pedicle is often absent (Fig. 133). Verneuil's term, "periosteal fibroma," is a better one, but this term must not exclude the co-existence of sarcoma, any more than this can be excluded in the so-called "fibrous epulis."

† "On Naso-pharyngeal Polypi": Dr. Brown-Séquard's *Arch. of Sci. and Pract. Med.*, No. 6. According to Dr. Sands, these fibromata may also spring from the apex of the petrous bone and the great wing of the sphenoid. Any intending operator will also do well to consult a very practical paper on this subject by Mr. Stonham, ***Westmin. Hosp. Rep.***, vol. iv. p. 61.

While the above are the most frequent *primary* attachments of the growths, it should always be remembered that when one of these fibromata has existed for some time, when they are sloughy, when previous attempts have been made to remove them—under these conditions the growth is very likely to have taken on *secondary* attachments. A common instance of these is seen when a growth springing from the base of the skull forms adhesions to the pterygoid fossæ.

If secondary attachments are made out to exist, the next question will be, how far are these intimate and close? How far is the growth not only in contact with, but how far has it actually absorbed bones, such as those of the nose? How far has it got into the antrum and thus come to resemble closely a growth of the upper jaw? It is obvious that if the growth is mainly limited to the nose, if the bones of the cavity are chiefly affected, it is through the nose that the fibromata should be attacked. Again, swelling of the cheek, with protrusion of the eye, will point to an operation, osteoplastic or otherwise, on the upper jaw. In the same way extension of the growth into the zygomatic and temporal fossæ will render the prognosis unfavourable. Finally, any symptoms pointing to softening of the base of the skull and implication of the membranes—*e.g.*, headache, tendency to coma,

FIG. 133.



Naso-pharyngeal fibroma springing from the base of the skull. In the sphenoidal sinus is seen a smaller growth. (Masse.*)

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* *These des Polypes naso-pharyngiens.* Paris, 1864.

convulsions, with evidence of pyrexia, will be conclusive against any operation, even when most carefully performed.

Methods of Removal.—Amongst these are:

(i.) **Avulsion.**—In a few rare cases where the growth is small, where the pedicle is distinct and narrow, and where it not only can be reached but also commanded (two different things), it may be torn away with suitably curved forceps introduced either by the nose or by the mouth, aided in either case by a finger passed behind the soft palate.

This method is only suitable to the above cases, and in none is it without danger. Mr. Cooper Forster's interesting case (*Clin. Soc. Trans.*, vol. iv. p. 159) is a striking instance of this.

Attempts having failed to remove the fibroma with a wire loop, Mr. Forster introduced a pair of blunt-pointed strong forceps, and twisted off several large pieces, enough to fill the palm of the hand. These were very adherent, and required a great deal of force to detach them. There was much hæmorrhage. Severe headache quickly followed, then aphasia, restlessness, convulsions, and death on the twelfth day. General arachnitis was found, with sloughy softening of the brain about Broca's convolution. The growth occupied the left side, filling the space between the greater and lesser wings of the sphenoid, the orbital plate of the frontal, and the cribriform plate of the ethmoid.* From the nasal fossæ it had extended by the sphenoidal fissure into the back of the orbit, but without damaging the optic nerve. The cribriform plate of the ethmoid was broken, there being a small opening at its back part from which a fracture extended forwards. This fracture had doubtless been effected while the growth was being torn away.

The serious hæmorrhage,† and the probable incompleteness of the operation, are also strongly against making use of avulsion. Here, as elsewhere, removal of malignant disease piecemeal is most unsatisfactory.

(ii.) **Ligature.**—This again is only suitable to very few cases—*e.g.*, where the pedicle is distinct and fairly thin, and where the growth has contracted no adhesions. In addition to the probability of return in the root, the fœtor which accompanies the sloughing process is a most serious drawback.‡ If the ligature were to be used at all, every attempt should be made to get rid of the growth at the time by attaching the ligature, after it is placed round the pedicle, to a suitable écraseur, and so removing it. A cold-steel wire tightened very slowly would be the best. Care must be taken in such cases to prevent the growth, when the pedicle is divided, falling upon the larynx. The artificial nail (p. 370) would, perhaps, be an efficient means of dealing with the pedicle.

(iii.) **Galvanic Loop.**—In the very few cases where ligature can be tried, this modification would probably be the best. But even here the pedicle would be left, unless the surgeon possesses special instruments, such as the post-nasal galvano-cautery, and experience in using it.

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* It is noteworthy that though this large growth (Mr. Forster describes it as "an enormous mass around which it was impossible I could get the wire") thus extensively implicated the base of the skull, it only appeared externally as a firm, fleshy polypus filling up a large part of the left nostril, but apparently not pressing much upon the right one. There was no dilatation of any part of the face, no fulness of the palate, nor any projection in the throat.

† According to Dr. Sands, Dupuytren lost a case from hæmorrhage after an attempt to remove a fibroma by forceps, in which he succeeded in removing only a few fragments. If this method is ever made use of, it would be wise to first perform laryngotomy, and plug the fauces with a sponge.

‡ Dr. Sands quotes other causes of death as not infrequent—viz., suffocation from detachment of the growth, pyæmia, and œdema of the larynx.

(iv.) **Electrolysis** This method is both most tedious and uncertain It can only be used as an auxiliary. Thus, Dr. Sands suggests that, after removal of the growth, its pedicle might be successfully treated by electrolysis.

Only when patients are weakened by repeated bleeding is it justifiable to use electrolysis in order to arrest the hæmorrhage, and thus reduce the growth sufficiently in size to allow of its being removed through the natural passages.

(v.) **Excision by an Operation involving Removal of Bone, Osteoplastic or otherwise.**—These cases may be divided as follows:

A. Those in which the attack is made through the mouth.

B. Those where the attack is made through the nose.

C. Those in which the attack is made by removing the upper jaw, partially or completely, or by resecting this bone osteoplastically.

A. *Operation for Naso-pharyngeal Fibroma through the Mouth.* This operation was strongly advocated by M. Nélaton. It consists in slitting the uvula and soft palate exactly in the middle line from before backwards, then prolonging this incision along the centre of the posterior half of the hard palate, going here down to the bone; from the end of this incision two others are made slightly obliquely outwards towards the teeth, also going down to the bone. The flaps, together with the periosteum, are then detached, so as to form nearly rectangular flaps.* Two large holes are next drilled through the hard palate, each well to one side of the middle line, the intervening bone is cut away by placing the ends of cutting-pliers in each of these holes, and, by making lateral cuts back to the free border of the hard palate, a rectangular portion of the posterior half of the bony vault is removed. The mucous membrane and the periosteum on the upper surface of the bone, which will now be found detached, are divided, and, if it be needful to get more room, more or less of the vomer is cut away. Room being thus obtained, the fibroma is removed and its attachment dealt with If all the growth is got away satisfactorily, the palate flaps are united in the ordinary way; if further treatment is required, staphylorraphy must be performed later.

Preliminary laryngotomy should be performed owing to the proximity of the larynx

The advantages of this operation, when contrasted with removal of the upper jaw, are at first sight considerable.

(1) There is no deformity left on the face; (2) the parts cut through are less important; (3) mastication is not interfered with by removal of the teeth; (4) the operation is said to be less difficult; (5) the hæmorrhage is claimed to be less,† no large vessels being cut through; (6) the

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* This detachment is, as is well known in staphylorraphy, difficult posteriorly at the junction of the palates, and is best effected by the raspatories (Fig. 183 p. 434)

† This is very doubtful. Bleeding from the divided and partially resected palate will be very near the aperture of the larynx Again, if troublesome hæmorrhage take place from the root of the fibroma, it will be more difficult to deal with it by this route than by the nasal or maxillary routes, or by a combination of these. Dr. Sands (*loc. supra cit.*), in removing a fibroma by this method, had surrounded, without difficulty, the pedicle

growth is attacked directly; (7) through the gap thus left the surgeon can again attack the growth, within a few days if he has been unable to complete the operation, or later on if recurrence takes place; (8) the gap can easily be dealt with later on by staphylorraphy, or by wearing an obturator.

The first three advantages are, no doubt, of great value if the growth can be entirely dealt with by this method; otherwise, considering the malignancy of these growths, the inveterate way in which they recur, if incompletely dealt with, neither surgeon nor patient would be wise in running great risks for the sake of what one may call rather æsthetic advantages.* There is no doubt that, in a few cases, to be mentioned a little later, where the polypus is of moderate size, distinctly pedunculated, and attached low down—*e.g.*, about the posterior nares, or well forward on the base of the skull—the operation will be easier, the hæmorrhage will be less, and the growth will be more directly attacked. The advantage of a future staphylorraphy is, like those given first, not of sufficient value to recommend this operation if it is wanting in others more important.

Turning to the cases themselves, Dr. Robin Massé has collected twenty-six treated by this method, twelve having been under the hands of M. Nélaton himself. Of these twenty-six, thirteen are said to have been successful, but it is not stated for how long they were followed up. In one case, in which the after-history is given, a small recurrence took place two years later from the pedicle, and was destroyed. While suited to the cases mentioned above, the method could scarcely be made use of successfully in large polypi, in the case of those with secondary attachments or large sessile bases, or in the case of those which have extended into the pterygoid fossæ, or, in fact, beyond the naso-pharynx. Save by French surgeons, it does not appear to have been much used, from the belief that the space given is too limited.†

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with an écraseur chain. This breaking, the pedicle, which was stout and firm, was divided with scissors as close to the skull as possible. Copious hæmorrhage followed, and much time was consumed in unsuccessful attempts to secure a large artery which had retracted to the deepest part of the wound, and which was inaccessible to the ligature. The bleeding finally ceased in consequence of the prostration of the patient, who had several alarming attacks of syncope. The growth recurring, it was removed by the method of Maisonneuve. Though it was not thought prudent to attempt the removal of a small prolongation which ran into the sphenoidal sinus, no recurrence had apparently taken place nine months later.

* I may here draw attention to the great frequency of these fibromata in males, in whom the growth of hair will largely conceal the facial deformity consequent on operations through the upper jaw. In young patients where the mouth is small and the growth large, this operation will be out of the question.

† Mr. Stonham (*Lancet*, Jan. 7, 1888) has recorded a case of naso-pharyngeal fibroma, in which "the soft palate was divided in the middle line, and an attempt made to remove the growth through the mouth; but this plan failing to give sufficient room, the nasal cavity was opened up," and the growth thus successfully removed. Mr. Walsham (*Med. Soc. Trans.*, vol. xix., 1896, p. 394), speaking in favour of this operation, said that he had had to deal with growths of this kind on several occasions, and had always succeeded in obtaining adequate exposure by splitting the soft and cutting away the hard palate. He pointed out that these growths, though they may extend into the nose, and even cause the eyeball to protrude, do not usually involve the turbinals or upper jaw; there was consequently, as a rule, no need for turning the jaw outwards to get a good

Dr. Sands points out that, in the majority of the cases in which surgeons have operated through the palate they have had to leave the wound open in order to remove the pedicle later. This step is by no means so easy as might be imagined, and in many cases the surgeon has been driven later to make use of another operation when the patient's condition was less satisfactory. Furthermore, repeated irritation, in the shape of attempts at destruction of the pedicle with caustics, the cautery, &c., is too likely to result in rapid sarcomatous growth.[*]

B. *Operation for Naso-pharyngeal Fibroma through the Nose.*—Under this heading will be included:

(1) Furneaux Jordan's operation.	(4) Langenbeck's operation.
(2) Lawrence's operation.	(5) Rouge's operation.
(3) Ollier's operation	

These operations through the nose are only suited to cases in which the pedicle of the fibroma is attached to a point well within reach. They may also be used in doubtful cases for exploratory purposes. In cases where the room which they give, and the access which they afford to the tumour, will probably be found insufficient, additional room must be obtained by removal of part of one or both maxillæ.[†]

(1) Furneaux Jordan's Operation.—I prefer this, when available, to any other by the nose. It is extremely simple, most efficient (especially when a growth has dilated the nasal cavities), and leaves most trifling scars. An incision like Sir W. Fergusson's being made along the side of the nose and through the lip, the nose is detached from the bone, and, the septum being cut through, is turned over on to the opposite side of the face. It is best adapted to nasal polypi of sarcomatous nature, and limited to one side; for naso-pharyngeal fibromata it does not give sufficient room.

(2) Lawrence's Operation.[‡]—In this, the back of the nasal cavity is exposed and got at by turning up the nose.

The integuments are first divided on each side of the nose by an incision beginning at a point just internal to the lachrymal sac, and carried down to the junction of the ala and the lip, across the upper lip, and then up to a corresponding point on the other side. Next, the incision is completed by cutting through the nasal bones and the nasal process of the superior maxilla with bone-forceps. The septum being now divided with strong scissors, the nose is turned up and the posterior part of the cavity exposed.

(3) Ollier's Operation through the Nose[§] (Fig. 134).

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exposure. Mr. Wallis (*ibidem*) also remarked on the excellent exposure which this method afforded him in a case of large naso-pharyngeal growth attached to the internal pterygoid plate

[*] Dr. Sands points out that the deep situation of the growth, and its position near the larynx, render the use of caustics both difficult and dangerous.

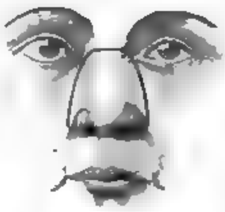
[†] M. Hergott (*Gaz. des Hôp.*, 1867, p. 97), in the case of a fibroma recurrent after treatment by ligature, tried rasping the point of implantation on the base of the skull. He found that an instrument passed through the anterior nares impinged exactly upon this point; the bone was easily denuded, and seven months afterwards no trace of reproduction was visible.

[‡] *Med. Times and Gaz.*, 1862, vol. ii. p. 491.

[§] A case by Dr. Rochard and Dr. Gougenheim, in which very large sequestra, due to

In this method the nose is, by an incision somewhat like the last, turned not up but downwards. M. Ollier begins his incision at the edge of the bone, close behind the ala of the nose, carries it upwards along its side to the highest part of the depression between the eyes, then across, down to the corresponding point on the other side. The bone is sawn through in the line of the incision, the necessary liberating incisions made in the septum and the sides, and the nose turned down. The septum is pressed aside, the polypus extracted, its base of implantation curetted or cauterised, and the nose replaced.

Fig. 134.



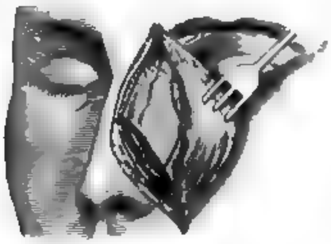
Ollier's operation. (Esmarch and Kowalzig.

A modification which is sometimes desirable on account of the size of the fibroma, or the distance of its implantation, is indicated in Fig. 201. The incision is made obliquely outwards upon the cheek, and a transverse one is made from each end inwards to the ala of the nose The bone is divided in the direction of the skin incisions —in the vertical one, as before described; in the horizontal one, by passing a fine saw across the nostrils, through holes made between the bone and cartilages, and sawing outwards. This line of section must be high enough to avoid the roots of the teeth.

Mr. Stonham, who has used Lawrence's operation three times successfully, prefers it to Ollier's, as the nose is turned upwards, and is thus not in the way of the operator. Again, the nasal bones, though broken across, are still attached by periosteum, and do not therefore run much risk of necrosing.

(4) Langenbeck's Operation by Excision of the Nasal Process of the Upper Jaw (Fig. 135).—A curved incision, with the convexity forwards, is made from the inner edge of the eyebrow on to the bridge of the nose, and thence downwards into the naso-labial fold. The flap of skin thus marked out is then dissected up in a backward direction. The nasal cartilage having been severed at its junction with the bone, a short, strong, narrow-bladed finger-saw is inserted into this opening, and the nasal process of the upper jaw is sawn through up to the lachrymal sac; the saw is next carried inwards through the roots of the nasal process of the superior maxilla and the nasal bone, and lastly downwards through the nasal bone itself. The removal of this sawn-out lamella, consisting of the nasal process of the upper jaw, part of the lachrymal and the nasal bone, gives space enough for inspection of the whole interior of the nasal cavity, the posterior nares, and the lower portion of the body of the sphenoid bone.

Fig. 135



V. Langenbeck's operation of resection of the nasal process and nasal bone. (Esmarch and Kowalzig.)

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tertiary syphilis, were successfully removed by Ollier's operation, after Rouge's operation had failed, is reported in the *Ann. de Malad. de l'Oreille, du Larynx, &c.*, Oct. 1896.

Though, as a rule, no deformity of the face follows on the removal of this piece of bone, von Langenbeck modified this operation into an osteoplastic one. Thus he sawed through the nasal process covered with the periosteum only, as far as the lachrymal bone, and upwards through the nasal bone, then inserting an elevator he raised the thin bony flap, which gave a way above. At the close of the operation this flap was replaced.

(5) Rouge's Operation. This has already been described at p 366.

C. *Operations for Naso-pharyngeal Fibroma by Removal of the Upper Jaw* (i.) *completely*; (ii.) *partially*; or (iii.) *by osteoplastic operation* on this bone.

(i.) *Complete Removal of the Upper Jaw.*—This has already been fully described (p. 379).

(ii.) *Partial Removal of the Upper Jaw.*—These operations are very numerous; one or two will be given as specimens.

Several of these methods either risk the removal of too much, as where one entire upper jaw is removed, or, where the removal is partial, additional access by a simultaneous attack through the nose will generally be required. Osteoplastic operations are very difficult, and therefore prolonged; and the hæmorrhage is severe. Such grave objections outweigh the advantage claimed for these operations, viz., of leaving less deformity.

a. Method of Maisonneuve[*] and Guérin.[†]

Dr. Robin Massé (*loc. supra cit.*, p. 51) states that the so-called operation of Maisonneuve is really that of Guérin, with only a modification in the division of the soft parts. The essential point is to get room for attacking the fibroma by removal of the lower part of the jaw. This bone being sufficiently exposed by raising the soft parts over it—and for this purpose the method of Sir W. Fergusson seems superior to those given by the above French surgeons—the hard and soft palate are then divided in the middle line, and the soft detached transversely on the side to be operated upon. The hard palate is next divided in the middle line by saw and bone-forceps, working from the nose into the mouth. By a transverse section with a narrow-bladed saw introduced into the nose, and made to cut horizontally outwards, the facial aspect of the bone is divided as far as the maxillary tuberosity.[‡] The lower part of the jaw is then strongly depressed, and thus detached, consisting of the alveolar and palatine processes, a portion of the body, and a varying amount of the pterygoid processes which usually comes away with it. The fibroma is then extirpated.[§]

b. Method of M. Béraud.

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[*] *Gaz. des Hôp.*, 21 Août 1860.

[†] *Elém. Chir. Opér.*, 1858.

[‡] This section should pass above the roots of the teeth and well below the infra-orbital foramen. Accurately speaking, it was mainly performed, in the hands of its introducers, with bone-forceps.

[§] Dr. Sands appends to his paper a photograph of the patient on whom he had operated by this method, after failing to remove the fibroma by the plan of M. Nélaton. The deformity is very slight, the malar prominence and the fulness of the cheek being well preserved.

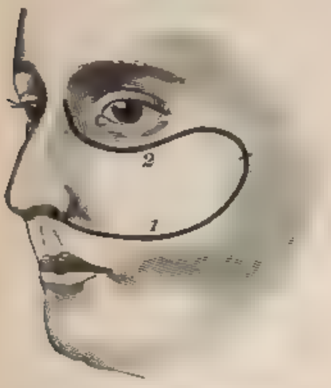
In this the upper, not the lower, part of the jaw is removed, so as to preserve intact the teeth and alveolar process of the palate.

In all these operations hæmorrhage may have to be met by a preliminary laryngotomy and plugging the fauces (pp. 453, 480); and also, perhaps, by a temporary ligature of the carotid (pp. 583—610. Afterwards, if the bleeding be severe, it will be advisable to plug the cavity firmly with strips of iodoform gauze wrung out of carbolic acid lotion (1 in 20) or turpentine.

(iii.) *Osteoplastic Operations on the Upper Jaw.*—In this the bone is cut through by various incisions, turned in different directions on some uncut attachments, as on a hinge, and then fitted down again after the removal of the growth.

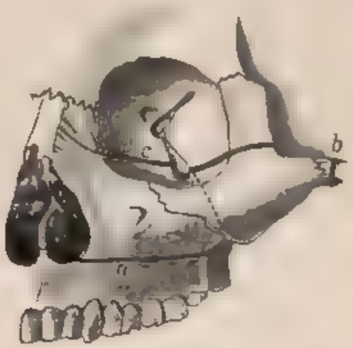
Method of Prof. Langenbeck † (Figs. 136, 137).—This is one of the best known of the above operations. Its object is to get at the fibroma, especially if it be one of the pterygo-maxillary fossa, without interfering with the alveolar and palatine processes or with the orbital plate. While this operation seems well suited to its object, its drawbacks seem to be considerable, for (1) there is the great difficulty of raising so fixed a bone, and again of getting it evenly into place: thus the operation is prolonged and the hæmorrhage severe; (2) if the upper jaw has to be sawn from behind forwards, this cannot be done easily unless the fossæ at the back of the jaw and the spheno-palatine foramen are much dilated; (3) if the growth has extended into the naso-pharynx, this region will not be well exposed; (4) very disfiguring scars are left, especially objectionable in the case of a female patient.

FIG. 136.



V. Langenbeck's osteoplastic and temporary resection of the upper jaw. The skin incisions are shown meeting on the zygoma.
(Esmarch and Kowalzig.)

FIG. 137.



The same operation. The lines for the saw through the zygoma and upper jaw.
(Esmarch and Kowalzig.)

Two semilunar incisions (1 and 2, Fig. 136), with their convexities downwards, are made across the facial aspect of the upper jaw, the lower running from the ala of the nose to the middle of the malar bone, the second starting from the nasal process of the frontal and passing just below the orbit to meet the first, where this ended. If needful, owing to the extension of growths backwards, the meeting of these incisions may be carried back along the zygoma (*b*, Fig. 137). Each cut is made down to the bone, but the skin is not reflected. To avoid needless loss of blood, the lower skin incision and section of bone are made first, and then the upper division of skin and bone. At the outer end of the lower one the masseter is detached from the zygoma, and if the growth has extended out into the zygomatic fossa it will now come into view on dividing the buccal fascia. Prof. Langenbeck found at this stage that by pressing the growth to one side and depressing the lower jaw he could pass his finger through the pterygo-maxillary fissure into the spheno-maxillary fossa, and so on through the spheno-palatine foramen into the nose, all these parts being enlarged by the pressure of the growth. By means of a narrow straight saw introduced the same way the upper jaw was cut through horizontally (*a*, Fig. 137) from behind forwards, while a forefinger passed by the mouth kept the tip of the saw from striking against the septum nasi. (If the right upper jaw is operated on, the surgeon will saw outwards from the nose.) The saw was now applied along the upper incision so as to divide the zygoma (*b*, Fig. 137), the frontal process of the malar, and the upper jaw (*c*, Fig. 137), just below the lachrymal sac, up to the inner end of the incision. The portion of the upper jaw thus marked out now only remained attached, at its inner part, to the nasal bone and nasal process of the frontal. Upon these connections, as upon a hinge, the piece of bone was slowly raised by means of an elevator introduced under the malar bone, upwards and inwards, until the malar bone was nearly in the middle of the face. The growth was now completely exposed. The operation took an hour, and was attended with much hæmorrhage, most of which stopped spontaneously. The wounds healed well, a tendency of the bone to rise being met by pressure.

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* *Deutsche Klin.*, 1861, p. 281; and Schmidt's *Jahrb.*, Bd. cxiii. p. 198.

At the present time any surgeon making use of the above operation would wire the bone when fitted down. I would suggest, too, that the incisions through the bones might perhaps be more easily made with an osteotome and mallet, especially in cases where, the deep parts at the back of the jaw not being so much dilated as in Prof. Langenbeck's case, it is difficult to manipulate a saw and to cut from behind forward.

Prof. Langenbeck's patient was a lad of 15. The growth could be felt by the finger in the mouth, filling up the posterior nares on the left side, passing out between the masseter and maxilla; and on this side, too, the zygoma appeared more prominent, and the temporal fossa more full.

An interesting account of temporary resection of the upper jaw for removal of a naso-pharyngeal growth is given by Mr. Stanley Boyd (*Med. Soc. Trans.*, vol. xix., 1896, p. 391). Though the hæmorrhage was "not considerable," intense collapse followed, and lasted two hours. The patient made a good recovery.

The Choice of an Operation for Removal of Naso-pharyngeal Fibroma.—The relative values of several of the above operations have already been briefly given. The surgeon will have to weigh duly the following: On the one hand, the desire to get the growth away with as little mutilation and danger to his patient as possible, and, on the other, the fact that these growths are most certainly malignant in nature, and that any partial operation, while probably as difficult and as bloody as one on a larger scale, will, if i[illegible]e, be certain to lead to increased growth in the tumour by [illegible] causes.

Whatever operation is chosen, it will usuall[illegible] diminish the risk of hæmorrhage, to perform a p[illegible] (pp. 453, 480), and to plug the fauce[illegible]sep[illegible] gotomy tube should usually be rem[illegible]

Destruction of the root of the fibroma is best effected by a powerful curette, aided by the cautery. The use of the latter is risky owing to the vicinity of the larynx, and the possibility of septic broncho-pneumonia from charred tissues. The risk of recurrence is, however, greater if the root be not completely destroyed. Iodoform should be thoroughly used at the time, and afterwards, aided by cocaine, by an insufflator passed behind the soft palate, or iodoform and ether (1 in 8) may be applied.

For naso-pharyngeal polypi which come early under treatment, in which the growth is of moderate size, with a pedicle situated well forward in the roof of the pharynx or within easy reach from the posterior nares, especially polypi which can be made out to occupy chiefly the region of the nose, such operations as those of Furneaux Jordan, or, better, that of Lawrence or Ollier, may be made use of.

In cases of greater difficulty, from the longer duration, more extensive attachments, larger size, and, with this last, the certainty of a more extensive base and numerous large sinus-like vessels, the question of deformity and disfigurement must be entirely set aside.* In order to secure adequate space for making certain of all the attachments of the tumour, for eradicating these, and, at the same time, satisfactorily meeting the hæmorrhage which is usually inevitable, a freer removal of bone will be required. No doubt, for this purpose, partial or complete removal of the upper jaw should follow the preliminary attack by the nose. Every surgeon who has performed removal of the upper jaw knows how free is the access which it gives to the back of the nose and to the pharynx. A further advantage, pointed out by Dr. Sands, is the following, that, owing to the wide gap left by this operation, recurrence of the disease can be more readily recognised and treated than after any osteoplastic operation.

But while willingly admitting the great advantages which removal of the upper jaw gives for free exposure of the growth, I cannot quite agree with Dr. Sands, who recommends this step on the ground that "excisions of the upper jaw are, as a class, remarkably successful operations." On the contrary, I should look upon this as a distinctly serious and grave operation (p. 383), especially in patients who, though young, often come before the surgeon with strength reduced by hæmorrhages, dysphagia, dyspnœa (especially when this is accompanied by attacks of choking interfering with sleep), sepsis, &c. Finally, while I am of opinion that a combined attack on these growths by the operation of Lawrence or Ollier, together with partial removal of the upper jaw when needful, will give sufficient access, with a minimum of deformity in most cases, the operator will do well to be guided not so much by the set operations of other surgeons as by what he meets in his own case. Only, anyone in doubt whether to get at the growth by some partial resection of the jaw, as by the method of Maisonneuve, aided, if needful, by cutting away the pterygoid process and septum,† or by making use of an osteoplastic operation, must remember that the tempting nature of the latter must never weigh too much with the surgeon, especially in cases where rapidity is of great importance, in a patient much pulled down, or where every atom of additional space is required to deal with the base of the growth, or to command serious hæmorrhage.

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* I may again remind the reader that these naso-pharyngeal polypi usually occur n males, often in lads or young adults. The growth of hair which can usually be ured in these cases lessens, to a considerable degree, the amount of disfigurement operations on a larger scale entail.

as to expose completely any outlying attachments in the pterygoid and fossæ, and to get full access to the pharynx and nose.

Dangers and Drawbacks of Osteoplastic and other Operations for Naso-pharyngeal Fibroma.—Many of these have been already given under the head of Removal of the Upper Jaw (p. 382); others, more particularly to be expected here, are:

1. Hæmorrhage, not from large arteries, as the internal maxillary, but from the fact that the very numerous vessels of the growth are embedded in close fibrous tissue and thus cannot retract, and that many of the veins are large and sinus-like. To meet this inevitable risk a preliminary laryngotomy should be performed, and the fauces plugged with sponge (pp. 453, 480). Hæmorrhage from the base of the growth, if persistent, may be arrested by the cautery.
2. Meningitis, from damage to the base of the skull (p. 385), or from inflammation spreading to the membranes of the brain. Mr. Stonham (*loc. supra cit.*, p. 78) states that "it is a common experience that after removal of these polypi the patient suffers from intense headache, principally referred to the occipital region, but it usually passes off in a few days."
3. Necrosis and exfoliation.
4. Non-union of a temporarily resected fragment.
5. Recurrence. The best protection against this risk is adequate exposure of the growth, especially its base, and then complete destruction of this by a powerful curette or the cautery.

TAPPING THE ANTRUM.

This operation is from time to time required for suppuration in the antrum, nearly always in adults, and most frequently after alveolar abscess.

It may be performed in either of the following ways: (i.) Through the alveolar process. (ii.) Through the facial aspect of the upper jaw, above the alveolar process.

(i.) *Through the Alveolar Process.*—This method has the following advantages: (*a*) It drains the cavity at the most dependent part. (*β*) By withdrawal of the tooth it often removes the cause of the trouble. (*γ*) It does not involve any cutting.

The disadvantage connected with this operation is, that, unless special precautions are taken, food tends to enter the antral cavity through the opening made by this method.

A tooth has usually to be first drawn, and, as long ago pointed out by Mr. Salter (*Syst. of Surg.*, vol. ii. p. 467), "the tooth whose fangs are most intimately connected with the antrum is the first permanent molar;* and its removal in a case of antral abscess is especially indicated from this circumstance, and from the frail and perishable nature of the tooth itself, which gives it less often than other teeth a long tenure of usefulness." This being done, the orifice made should be enlarged by pushing a trocar or, better, a drill or gimlet up through the alveolus. Whatever instruments are used should be of sufficient size to ensure a free orifice, and, in driving them up through the bone, care should be taken that, when they enter the antrum, they should not plunge against and perforate the orbital plate. The opening, when made, is best widened by a "rat's-tail file."

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* Any other tooth, as Mr. Salter advises, molar, bicuspid, or canine, whose disease is possibly the cause of the abscess, will, of course, be extracted, as absorption round any *carious* tooth facilitates perforation of the alveolus.

(ii.) *Above the Alveolar Process.*—If the offending tooth has already been extracted (perhaps a long time before), if the alveolar process is largely absorbed, or its remains condensed, it will be preferable to make the opening above the process. This may be effected by everting the cheek, incising the mucous membrane, and thus exposing the bone above the position of the second molar tooth, and then perforating here with a gimlet or drill, and completing it in the way advised above.

Where the bone is much condensed, the instrument used in perforating will be held so tightly that the surgeon will need to withdraw it once or twice and use a probe before he can make certain of having opened the antrum. The opening should be large enough to admit an ordinary wooden lead-pencil, and should be kept midway between the two alveolar plates.

The antrum having been opened by one of the above methods, the chief objects are, getting and keeping sweet the cavity of the antrum and preventing any food making its way in here, while at the same time the artificial opening is kept patent.

To ensure these ends frequent syringing through a bit of gum-elastic catheter must be made use of, the lotion used being mercury perchloride, carbolic acid, iodine tincture, or potassium permanganate—the lotion itself not being of so much importance as the assiduous frequency with which it is used. After a while, when the discharge is no longer offensive, and no inspissated putty-like stuff comes away, some such astringent as silver nitrate (gr. 1 or 2—℥j.) may be used.*

To prevent the entrance of food, and at the same time to keep the opening patent, a short tube should be worn, let into a plate fitted over the perforation. Through this tube the patient can readily syringe out the cavity by an antrum syringe with flexible tubing attached; and by the insertion of a small cork, wood or metal pin, the entrance of food can easily be prevented. When there is no longer any need to keep the artificial opening patent, removal of the short tube and plugging the hole which held it will facilitate, by excluding air, saliva, &c., the closure of the antral opening. If this is still tardy, it may be hastened by the careful application of the cautery.

In a few very obstinate cases, as recommended by Mr. Newland Pedley (*Guy's Hosp. Rep.*, 1894), a free permanent opening may be required.

REMOVAL OF THE LOWER JAW, PARTIAL OR COMPLETE.

Indications.—These are much the same as those already fully given for removal of the upper jaw (p. 374). Mr. Butlin (*Oper. Treat. of Malig. Dis.*, p. 137) has treated of these growths, and has pointed out that here important differences are observable between the central and subperiosteal sarcomata. Thus the central (most often myeloid) sarcomata grow slowly, the subperiosteal quickly; the former are encapsuled, and even when they make their way into the surrounding structures they do not show that tendency to infiltration which is so marked in the subperiosteal sarcomata. The central ones are rarely associated with affection of the lymphatic glands, or with secondary growths.

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* The patient should be warned at the commencement how very tedious these cases are, and told of the need of persevering and patiently prolonged treatment.

The following operations will be considered:

A. Partial removal of the lower jaw.
B. Complete removal of one half of the lower jaw (Fig. 139).
C. Complete removal of the jaws, upper or lower.

A. **Partial Removal of the Lower Jaw.**—This is frequently required in the case of epulis. The steps are the same as those given already at p. 374. The alveolar border should always be removed: in the case of a growth very far back around the lower molars it is quite justifiable to slit the cheek, especially if the growth is becoming doubtful in character, and thus requires thorough extirpation.

The above remarks still more hold good in the case of a growth about the gums, situated far back, in an older patient, and becoming epitheliomatous.

Cases are occasionally met with where, owing to an epithelioma of the lip not having been treated, or to its recurrence, the symphysis of the jaw is infiltrated and requires removal. The soft parts being reflected by incisions on either side of the diseased parts converging towards the hyoid bone, and the vessels secured, the bone is sawn through in two places,* well beyond the level where its softened, spongy state and the loosened teeth show that it is invaded. The tongue, prevented from falling back by a loop of silk passed through its tip, is now detached by snipping through the mucous membrane, and the muscles attached to the genial tubercles. Any further hæmorrhage being looked to, the sub-lingual and sub-maxillary glands are examined, and, together with any enlarged lymphatic glands, removed if needful; flaps are dissected up from the neck to make a new lip (p. 418, Fig. 163): and drainage provided, the tubes being brought out below at the lowest level of the region from which the flaps have been dissected up. The adjustment of these to form the new lip will be the more easy in proportion to the amount of bone removed.

So, too, occasionally in epithelioma of the angle of the jaw, primary, or secondary to that of the tongue, the surgeon may be led, in order to relieve his patient's condition, if he cannot cure him, to operate extensively here. Thus, after turning up a horse-shoe-shaped flap, with the concavity upwards, and clearing the masseter off the jaw, the bone is divided above the angle, then through the horizontal ramus and removed, together with the sub-maxillary, sub-lingual, and lymphatic glands, which will probably be enlarged, and also adherent. The hæmorrhage will be free, from the facial and lingual vessels, and veins communicating with the external jugular. Free drainage must be provided.

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* Mr. Heath (*Dict. of Surg.*, vol. i. p. 839) gives the following practical hint with reference to dividing the jaw in two places: "In making these sections it is better not to complete one before the other is begun, because of the loss of resistance consequent upon breaking the continuity of the bone, but each cut being carried nearly through the bone with the saw, may be conveniently finished with the bone-forceps."

Removal of part of the horizontal ramus or of the angle may be called for in cases of new growths limited to these parts; and the surgeon may, especially in the case of women, ask how far it is worth while to try and remove these from the mouth, detaching the soft parts with a raspatory, and sawing the bone in front and behind the growth, as in the case of an epulis, but the section here passing through the whole thickness of the jaw. Mr. Maunder on two occasions removed large portions of the bone in this way. The following remarks of Mr. Heath (*Dict. of Surg.*, vol. i. p. 837) should be carefully considered before the surgeon, for the sake of avoiding a scar which will be but little noticed, undertakes a much more difficult operation, and one which, owing to the limited space it gives, may tend to his working dangerously near the growth: "The principal difficulty in these operations was not so much the separation of the tumour, as its 'delivery' through the mouth, which was slightly split in one instance. Fortunately the hæmorrhage in both cases was slight, and the patients did well; but another surgeon was less fortunate, and lost his patient by secondary hæmorrhage, but considering the close proximity of the facial artery, and the necessary division of the inferior dental artery, this is not to be wondered at. It may be doubted if the extra trouble and risk of the proceeding are balanced by the absence of a scar, which, in the majority of cases, need not involve the lip, and, if properly placed, will be nearly invisible afterwards."

Question of removing a Portion or the Whole of One Lower Jaw.—This matter will have to be decided when the surgeon, having a case of growth before him which involves the horizontal ramus as far back as the angle, is in doubt whether to saw through the vertical ramus or to disarticulate. In the great majority of cases, especially where the patient is no longer young, where the growth is not a central one, where it has been attacked before, the operator had much best place his patient and himself on the safe side and disarticulate. The lower jaw being "a floating bone," this radical step often gives a better prognosis for operation here than in the case of the upper jaw. On the other hand, the lower jaw is so embedded in soft parts, and so near to important parts—*e.g.*, pharynx and pterygoid fossæ—that delay may render the extirpation of the growth impossible. I would refer my readers to two cases in which, after partial operations in Mr. Heath's hands (Hunt. Lects., *Brit. Med. Journ.*, June 18 and July 2, 1887), fatal extension and recurrence of the growth took place.

B. **Removal of Half of the Lower Jaw** (Fig. 139).—The patient's shoulders being supported, and a preliminary laryngotomy performed if the growth is so vascular as to make plugging of the fauces a wise precaution, the surgeon, standing usually on the same side, makes an incision from just below the lip* down through the tissues on the side of the chin, then along and below the border of the lower jaw to the angle, and next up to a little below the lobule of the ear. The finger of an assistant is placed on the facial artery as soon as it is cut in this incision, and when it is completed the ends should be tied or twisted at once. The flap thus marked out is raised upwards, the masseter going with it if sound, and the cavity of the mouth opened by dividing the buccal mucous membrane at its junction with the alveolar border. An incisor being extracted if needful, the jaw is divided to one side of the symphysis well in front of the growth, by means of deeply notching it with the saw* before using the bone-forceps. If it be needful to remove the bone so freely that the symphysis and the genial tubercles are removed also, the tongue must be carefully prevented from falling back upon the larynx by means of a loop of stout silk passed through the tip. The bone being divided and pulled outwards, the knife is passed along the inner side of the jaw so as to detach the mylo-hyoid, with perhaps the digastric and the mucous membrane, and, at the angle, the internal pterygoid. In doing this the knife should be kept very close to the bone so as to leave behind the submaxillary gland

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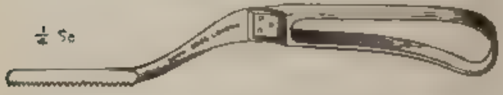
* If there are reasons for especial speed, such as the condition of the patient, or if the growth is very large, the red border should be divided, as this facilitates matters much, and the additional deformity is very slight.

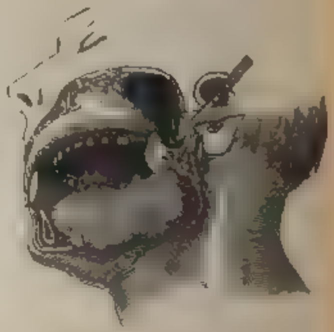
Fig. 138.



Gant's saw A form very convenient for section of the jaws. (Down Bros' Cat.

The anterior half of the jaw being thus freed, the surgeon, taking it in his left hand, everts it so as to divide the internal pterygoid more freely, and also the inferior dental nerve and vessels. The jaw is next strongly depressed so as to bring down the coronoid process, and the insertion of the temporal muscle. This strong tendon requires complete division, as depression of the bone brings fasciculus after fasciculus into view. If the coronoid process is very long it may hitch against the malar bone or be jammed against it by the bulk of the tumour: in such case it had better be cut off with bone-forceps, and, after the removal of the growth, dragged down with sequestrum-forceps and removed. After the temporal tendon is thoroughly detached (when this is effected the jaw comes down more easily), strong depression of the jaw is continued so as to bring the condyle within reach, no eversion or rotation outwards of the bone being permissible at this stage of the operation, or the internal maxillary artery, which passes between the neck of the jaw and the internal lateral ligament, will be brought into the wound, and very likely cut, causing troublesome hæmorrhage. The inferior dental nerve and muscles being divided, and the external pterygoid fibres partly torn through with the finger or the director, the capsular ligament is opened in front with the careful use of the point of the knife, which next keeps

Fig. 139.



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* When the condition of things admits of it, the jaw should always be divided as far from the symphysis as possible, in order to preserve the anterior belly of the digastric and its insertion, which will thus counteract the tendency of the muscles on the opposite side to draw the chin somewhat over. It is convenient to be provided with a Gant's saw (Fig. 138), or one with a movable back.

close to the bone, divides the lateral ligaments, when the jaw comes away, the final separation being usually effected by the remaining fibres of the external pterygoid being torn through, together with the stylo-maxillary ligament and the periosteum to which it is attached. The knife, if it is required here, should be kept very closely in contact with the posterior border of the ascending ramus.

If the internal maxillary artery has been divided, which is sometimes excusable in cases of large growths extending far up, it can be readily secured in the large wound.

If the operator finds the vertical part of his incision insufficient, and yet does not like to prolong it for fear of damaging the chief part of the seventh nerve, the soft parts should be forcibly dragged upwards with a retractor, after being pushed upwards with the handle of the scalpel.

In cases where the jaw has been extensively thinned or eroded by growth it is very likely to fracture under the depression which is required to bring down the condyle. If this accident occur, removal of the condyle and coronoid process is rendered difficult, as the latter is drawn upwards under the zygoma by the temporal muscle. Their removal will be facilitated by dragging them down with lion-forceps and detaching the temporal tendon with blunt-pointed scissors. If the growth is wedged in firmly above the soft palate, the chief mass should be removed by cutting through the upper part of it, and sawing through the ramus just below the coronoid process. The part of the jaw thus left is then disarticulated, and the rest of the growth removed.

All hæmorrhage being arrested by ligature or sponge-pressure, any enlarged glands, including the sub-maxillary if affected, are removed. The flap is then brought down, and adjusted with one or two points of silver suture and sutures of salmon-gut and horsehair, drainage being first provided for by bringing a drainage-tube from the neighbourhood of the condyle through the wound below. Iodoform with collodion is then brushed over the wound.

Especial care must be taken in exactly uniting the red line of the lip if this has been divided.

The wound is then dressed, as at p. 381, and the patient here also should be propped up to facilitate escape of the discharges. For the first few days it may be well to feed by a nasal tube, or by rectal enemata and suppositories. The patient should wash his mouth out as frequently as possible, as directed at p. 381.

In order to prevent the deformity which follows on this operation, especially in women, the surgeon should, with the help of a dentist, make use of some inter-dental splint and spiral wire spring, such as that of Dr. McBurney, of New York (*Annals of Surgery*, July 1894).

In cases where a large part of the mandible is removed, too large to admit of wiring, we still want some means easily adaptable, non-absorbent and non-rusting, which will prevent the great deformity which otherwise ensues. Mr. Pearce Gould brought this matter before the Odontological Society (*Lancet*, Jan. 16, 1897, p. 179).

Difficulties and Possible Mistakes during the Operation.

(1) Slipping back of the tongue, if the symphysis has been removed. (2) Wound of the pharynx by not keeping the knife close to the bone in separating the soft parts from the angle of the jaw. This interferes with the patient's being able to swallow from the very first.

(3) Fracture of the jaw. (4) Jamming of the coronoid process. (5) Rigidity and permanent contraction of the temporal, masseter, &c. (6) Wound of the internal maxillary vessels. (7) Outlying growth in the temporal region, or near to the tonsil and large vessels.

C. Operations for Complete Removal of Both Jaws.*

Before leaving the subject of removal of the jaws, a few words may be said of those rare cases which occasionally call for removal of both the upper, or the whole of the lower jaw, or both the jaws on the one side.† Space does not admit of my doing more than give brief references to a few cases.

The growths which call for removal of both upper jaws simultaneously fall mainly under the two heads—(α) Epithelioma of the palate and alveoli involving one or both of the antra;‡ (β) Growths usually sarcomatous, springing often from the base of the skull or some part of the naso-pharynx, and projecting forwards the jaws with hideous deformity.§ These cases are much less favourable than the epitheliomata.

In either case the parts are exposed by slitting the centre of the upper lip and then carrying the incision round the nose on either side Fergusson's incision being made use of as far as needful In a few cases, in order to get adequate room, it may be needful to make incisions from the angles of the mouth to the malar bones, and raise all the intermediate soft parts as a flap Wherever it is feasible, as in cases where the growth has begun in the alveolar processes, the infra-orbital plates should be retained. This may be done by sawing through both bones from the nose outwards, and completing the separation of the lower part of the maxillæ from the upper by an osteotome or chisel. After the full account already given of removal of the upper jaw, no description need be given of these operations for removal of both halves simultaneously The greater risk of shock, the liability to more profuse hæmorrhage, the probability of finding the growth extending far back into the different fossæ and along the base of the skull, are obvious. Later on, if the patient make a good recovery, the help of a dentist will be much needed in fitting some form of obturator, as articulation is now much more imperfect. The deformity is also obviously far greater. In fact the operation is only justifiable in a patient of good vitality and with increasing pain from pressure on the nerve foramina.

Question of Gouging, &c., in preference to Partial Removal of the Jaw.

The treatment of dentigerous cysts, if simply cystic and uncomplicated by growth, by measures short of removal of part of the jaw, has already been given (p. 376). Treatment on the same lines—viz., extraction of teeth, freely opening up the cyst by cutting away part of its walls. turning out its contents, and then obliterating it thoroughly by vigorous gouging wide of the disease—has been tried in other cases, especially in those cases of cystic disease, more common in the lower than in the upper jaw, the multilocular variety of which has been called by Mr. Eve "cystic epithelial tumours." This so-called "enucleation" should be adopted with the greatest caution. In young patients with cysts and fluid contents and no intracystic growth the above method is permissible, as it leaves no deformity. These cases will always require careful watching afterwards. Where there is any solid growth, neither gouging nor enucleation is permissible.* Their use in anything approaching to the periosteal sarcoma† is to be condemned in the strongest terms.

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* It is not always easy to tell the limits of a jaw-growth Thus one of these may extend up to the level of the lower part of the ear, bulge forwards close up to the nose, creep low down in the neck, and yet originate in the lower jaw. In deciding to which jaw a growth belongs, attention should be paid to involvement of the floor or roof of the mouth, and the results of masticatory movements.

† Mr. Spanton (*Brit. Med. Journ.*, 1885, vol. ii, p. 64) records a case in which first the upper and a few months later the lower jaw on the right side became the seat of malignant disease The jaws were removed at an interval of a week. The patient, aged 55, recovered from the operations, but the lower growth quickly recurred.

‡ Godlee, *Clin. Soc. Trans.*, vol. xx. p 260.

§ J. Lane, *Lancet*, Jan. 25, 1862, Dobson, *Brit. Med. Journ.*, Oct. 11, 1873.

OPERATIONS TO RELIEVE FIXITY OF THE LOWER JAW (Fig. 140).

SUTURE OF DISPLACED FIBRO-CARTILAGE.

The above condition may be due either to changes in the temporo-maxillary articulation resulting in ankylosis, or to cicatricial bands between the jaws, or to both.

Operations.—The two usually performed are:

(i.) Excision of the condyle, an operation indicated when the mischief is limited to the joint itself.

(ii.) Esmarch's operation of removing a wedge of bone from the horizontal ramus in front of the cicatrices and masseter; this operation being preferable to the first when scars are present which interfere with excision of the condyle.

Conditions justifying One of the above Operations.—Inability to open the mouth, resisting use of wedges, &c.* Fœtor of saliva and breath. Difficulty of speech. Inability to eat solid food. The above are brought about by the following causes, which will be enumerated together here, though some call for one of the above operations and some for the other—viz.:

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* Mr. Lawson brought before the Clinical Society (*Trans.*, vol. vi. p. 20) the case of a man, aged 65, in which he succeeded, by excision and application of zinc-chloride paste, in removing an epitheliomatous growth of the upper jaw fungating through the skin of the face. The growth recurred twice during convalescence, and on each occasion an anæsthetic was given, and the actual cautery and the zinc-chloride paste applied. Mr. Lawson points out—(1) that patients advanced in life stand large cutting operations, such as the complete removal of the upper jaw, very badly, whilst they will bear with but little shock the destruction of large growths by escharotics; (2) that the treatment was accompanied with very little pain; (3) that the deformity produced by such an operation is much less than that after an equally efficient operation by the knife which would have involved cutting widely of the growth. It is to be regretted that no details are given of how the growth was excised, nor of how much of the bone was removed. Furthermore, the report is only carried on to four months after the patient's leaving the hospital.

† An instructive case of subperiosteal sarcoma, which was three times treated by gouging—rapidly recurring each time—and twice by removal of parts of the jaw, is given in the *Lancet*, 1889, vol. ii. p. 1168. Death took place from a recurrence in the floor of the mouth within seven months of the first operation. Those familiar with surgical literature will recall many similar cases.

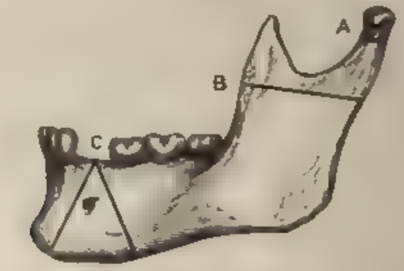
1. Inflammation of the joint set up by a punctured wound,† gonorrhœal arthritis, severe contusion‡ or sprain, osteo-arthritis,§ or suppurative arthritis, from abscesses burrowing into the joint, *e.g.*, abscesses connected with otitis media. 2. An unreduced dislocation in which much stiffness remains after attempts at reduction have failed, in a patient healthy and not advanced in life. 3. Cicatrices after sloughing set up by scarlet fever, measles, typhus, cancrum oris, or mercurial stomatitis. 4. Cicatrices after suppuration due to necrosis or alveolar abscess. 5. Periostitis of the malar bone after suppuration, fixing the condyle to the inner surface of the zygoma (Heath, *Brit. Med. Journ.*, 1884, vol. ii. p. 1191).

Excision of the Condyle (Fig. 140).—This operation is indicated when the mischief is limited to the joint itself, as in the first two conditions given above.

It may be performed as follows:

An incision about 1½ inch long is made on a level with the tragus along the lower border of the zygoma. The parotid and branches of the facial nerve being drawn down, the masseter fibres are cleared away from their insertion with a narrow elevator, and the joint exposed. The

Fig. 140.



A, Excision of condyle. B, Excision of coronoid and condyloid process. C, Esmarch's operation. This must always be in front of all cicatrix tissue. It happens to correspond here to an edentulous part of the jaw.

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* Mechanical apparatus must be used early to do any good. Daily forcible use of levers is usually unsatisfactory, and the use of interdental shields can do little more than retard scar-formation.

† *Cf.* Mr. Hilton's case (*Rest and Pain*, p. 114), in which bony ankylosis of this joint and of the upper cervical vertebræ seemed to date to a punctured wound in the neck.

‡ Mr. Heath (*R.C.S. Lects.*, 1887, vol. ii. p. 114) mentions a case in which ankylosis of the temporo-maxillary joint followed on a kick from a horse on the side of the face. In such cases a fracture may co-exist.

§ Good illustrations of this condition are given by Mr. Heath (*Brit. Med. Journ.*, 1887, vol. ii. p. 55). The fibro- and articular cartilages will probably be wanting. See also Prof. Humphry's case. *A Report of Some Cases of Operation*, pamph., 1856.

neck of the condyle is now sawn through with a fine saw, or divided with an osteotome, and the condyle turned out with an elevator, the external pterygoid being detached. The fibro-cartilage is left behind. The bone, which must not be splintered, should then be further pared down; and the operation will very likely need repeating on the opposite side before sufficiently free movement is regained. While the patient is still under the anæsthetic the mouth should be opened with a gag to a full inch at least, more if possible, and this should be frequently repeated with the aid of nitrous oxide or ether, and the case watched most carefully owing to the frequency with which relapses take place.

In severer cases it will be advisable to remove the coronoid process as well, and thus leave a wider gap. Dr. Mears (*Amer. Journ. Med. Sci.*, 1883, p. 459) considers that this method has the advantages of being applicable to all cases, and of giving better results, and I entirely agree with him from my experience of it in one case in which the result was excellent. A little facial paralysis, usually temporary, is often present after removal of the condyle. After more extensive interference with the soft parts, there is a greater risk of its being permanent. After severe operations here, followed by much swelling, the best dressing will be hot creolin or boracic-acid fomentations with a little sterilised iodoform, frequently renewed. To prevent recurrence of the stiffness, every means should be taken to ensure asepsis of the wound throughout. If hæmorrhage occur, plugging with sterilised gauze must be made use of.

Esmarch's Operation (Fig. 140).—Where the fixity is brought about by cicatrices within the mouth rather than by mischief limited to the joint, removal of a wedge-like piece of bone, in front of all scars, is to be preferred. Division of the bands inside the mouth is absolutely futile, and attempts to cover the wounds, made by excision of scars, with flaps of mucous membrane or skin are difficult, bloody, and disappointing.

An incision 2 or 2¼ inches long is made along the lower border of the jaw in front of the masseter and cicatrices. This incision should go down to the bone: the facial artery will probably need securing. A triangular wedge of bone is then removed with a narrow saw and bone-forceps. The sections should be made as cleanly as possible to avoid risk of necrosis, and the periosteum should be removed with the bone. The wedge should measure at least 1¼ inch below and ¾ inch above,* and it must be taken from a part entirely in front of any cicatricial tissue.

If possible, its apex should correspond to an edentulous gap in the alveolar process. If the dental artery bleed freely, a heated wire must be applied, or the foramen plugged with a tiny sterilised plug.

Owing to the tendency to relapse,† passive and active movement should be made use of early, and at first, if needful, with the aid of an anæsthetic.

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* In two of Mr. Heath's cases the wedge removed included the mental foramen.

† This relapse is more likely if the wedge is not removed well in front of all cicatrices. Thus, Mr. Heath (*Dis. and Inj. of the Jaws*, p. 332) found, two years after Esmarch's operation for complete closure of the jaws, that the interval between the left molars had diminished from ⅞ to ⅛ inch, and that between the lateral incisors from ⅝ to ⅜ inch. Mr. Heath thought that in this case he had not been sufficiently careful to make the bone section entirely in front of the cicatrices.

The operation should be performed early in cases where cicatrisation after severe ulceration is leading to increasing fixity of the jaw, ultimately needing operative interference.

That well-known surgeon Mr. Swain, of Plymouth, who advocates Esmarch's operation strongly, as preferable to the operation on the condyle, published a most successful case (*Lancet*, vol. ii. 1894, p. 189), in which he operated on both sides simultaneously, by a modification of Esmarch's operation.

> The jaws had been closed, after scarlet fever, for thirteen years. An incision about an inch and a half long was made just at the angle of one jaw, and then on the other side, parallel with the line of the jaws, the point of the angle being at the centre of the incision. The knife was carried at once down to the bone. With a raspatory the whole of the periosteum on the outer and inner surface of the angle of the jaw was lifted from the bone, together with the insertions of the masseter and internal pterygoid. A narrow saw was then applied, and a triangular piece of bone removed, including the angle of the jaw, and measuring at its base about one inch.

Mr. Swain thus compares his modification of Esmarch's operation, with removal of the condyle: "From an anatomical point of view there can be no doubt that the operation is a far simpler one. The incision is so placed behind the angle of the jaw as to be hardly perceptible. The careful raising of the periosteum from the bone not only renders the future steps of the operation almost bloodless, but affords great support to the central portion of the jaw, especially when, as in my case, both sides are operated upon simultaneously. The only really important parts divided are the inferior dental artery and nerve. From the artery there is little or no hæmorrhage, and should it occur it is easily controlled by plugging. The division of the nerve is absolutely of no importance, the only result being slight anæsthesia over the chin. The division of the bone at the angle sets free the whole of the masticatory apparatus of the lower jaw, which can be at once opened to its full extent. The subperiosteal method preserves the attachment of the masseter and internal pterygoid to the inner surface of the angle, thus keeping intact the two elevator muscles. If a sufficiently large wedge is removed the danger of relapse is very remote." Mr. Swain collected in his paper nineteen other cases of operation for closure of the jaws, of which twelve were cases of removal of the condyle or portions of the neck. In very few of the former was the result comparable with that obtained by Mr. Swain in his case.

Suturing of a Displaced Inter-articular Fibro-cartilage.—Where subluxation of the cartilage does not yield, as it usually will, to blistering, tonics, &c., and troublesome clicking and catching of the jaw persist, Prof. Annandale has twice successfully operated as follows (*Lancet*, 1887, vol. i. p. 411): An incision about three-quarters of an inch long is made over the posterior margin of the external lateral ligament, and carried down to the capsule. Bleeding having been stopped, the capsule is opened, and the fibro-cartilage seized and drawn into position, then secured by catgut to the periosteum and other tissues at the outer margin of the joint.

CHAPTER VIII.

OPERATIONS ON THE LIPS.

HARE-LIP AND OTHER PLASTIC OPERATIONS ON THE LIPS.

HARE-LIP (Figs. 141 to 156).

Best Time for Operation.—Any time after the second or third month. For most cases the third to the sixth month is the best. All should be over by the seventh month, when dentition begins.

With regard to operations at an earlier or later date than the above, it is interesting to note what Sir W. Fergusson, whose experience was unrivalled, advocated with a riper experience. Thus, in his *Practical Surgery* (fourth ed. p. 573, 1857), he wrote: "I have myself operated very frequently within the first three weeks"; and a little later, "From all my reflections and experience on the question, I am more than ever disposed to recommend a very early operation." In his *Royal College of Surgeons Lectures on the Progress of Anatomy and Surgery* (1867), with an experience of between 300 and 400 cases, he wrote: "I decidedly prefer about the end of the first month." Writing later on (*Brit. Med. Journ.*, 1874, vol. i. p. 403), Sir William stated that his favourite time was from "three weeks to three months."

While the rule of British surgery is to get the operation over before dentition, many German surgeons defer taking any steps till the child has entered on the second year. Thus, Prof. Billroth* announced his practice as follows:—"Unless the parents urgently demand an operation as early as possible, I generally prefer to operate on children when they are more than one year old. I always advise this in strong children with complicated hare-lips, especially when the inter-maxillary bones are displaced and the hare-lip is double. I have been particularly satisfied with the results of operation, as far as appearance is concerned, on children at rather later periods of life and in adults." Some further remarks of Prof. Billroth are quoted at p. 417.

My reasons for deferring the operation, as a rule, till after the third month, are:

1. The difficulties of getting children with hare-lip to take sufficient food are exaggerated. Very often, unless the palate is cleft in addition, these children can suck well, and are in good condition. When the palate is also cleft, a serious difficulty may arise from the food passing

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* *Clin. Surg.*, Syd. Soc. transl., p. 78.

into the nose, but this may be usually met by careful feeding with a small spoon put well back, if a sucking-bottle with a large teat and a good-sized hole in it fails (p. 428). This it will very rarely do, if slowly raised so as to give a little milk each time. Sometimes it is best to have the child raised when fed. The mother's milk should always be drawn and given when possible.

When the child really cannot get sufficient nourishment, and is marasmic from this cause only, the surgeon may, of course, operate before three, or even two, months. But a child that is daily wasting is, daily, less and less able to meet the strain entailed by the operation, and consequent repair. This should be clearly understood by the friends, and also the following fact:

2. It is not uncommon for children with hare-lip to die soon after birth from causes quite apart from this deformity—viz., diarrhœa, lung-trouble, exhaustion. In other words, many children with hare-lip suffer also from atrophy and wasting. In such, operation is unadvisable. It will not mend matters, and death will be put down to it, and not to the above causes, which would have destroyed the child in any case. In another, smaller, class of cases the operation itself, chiefly from the pain it causes in a weakly child, seems to start a process of fatal wasting.

3. As stated by Sir T. Smith (*Lancet*, 1867, vol. ii. p. 761), "The operation can be done much more perfectly and artistically on a young child than on a new-born infant, the parts being larger, more fleshy, and more easily handled." Sutures also cut out less readily.

4. For the first few weeks of life the child has scarcely got over the change from intra-uterine to extra-uterine life, the digestion is not yet, so to speak, in full swing, and a very slight shock may be too much for the low vitality of this period.

Condition of the Hare-lip.—Before operation, the following must be inquired into. Is the cleft single or double? If single, is it simple—*i.e.*, without involving the nose, and without fissure of the palate? Are the sides equal and acute-angled, or divergent and unequal? Other sources of difficulty are, much flattening of the nose from the septum being adherent and dragged over to the superior maxilla on one side, and the ala of the opposite side being spread out and stretched over the upper part of the fissure. Or the edges of the lip are widely apart, and by no means to be approximated, the alæ being so widely separated that lines let fall vertically through them only just come within the angles of the mouth.

Other more general points will, of course, be remembered as influencing the result of the operation. Amongst these are, the digestive and sleeping power of the infant; its family history; the existence of any weakening condition, such as otorrhœa; and, by no means least, the good sense and patience of the nurse.

The **Single Hare-lip** operation and the one applicable to the largest number of cases will be first described fully, and then some other modifications.

(i.) **The Usual Operation** (Fig. 141).—The child being wrapped in a towel, mummy-wise, to ensure the hands being secured if it "come to" prematurely, A.C.E. or ether is given fully, and the head is held suitably presented to the operator by an assistant, whose hands, at the same time, make pressure upon the facial arteries as they cross the jaw. The lips, and, if needful, the alæ also, are now freely separated from the subjacent bones to allow of their coming together without tension. During this step the knife should be kept very close to the bone, otherwise the hæmorrhage will be free. Unless this step be thoroughly carried out, the tension on the sutures a little later will be certain to interfere with successful union. To render the separation efficient the knife must sometimes be carried quite up to the infra-orbital foramina, while the alæ nasi must also be thoroughly separated so that any flattening and distortion of the nostril may be rendered shapely.

If one maxillary bone project inconveniently beyond its fellow, it must now be forced back into place with the finger and thumb,* or with non-serrated forceps covered with thin drainage-tube. The bone should be felt to crack when this is done; otherwise, if merely bent back, it springs forward again and causes tension on the flaps.

If it is really necessary, as in an older patient, the anterior plate of the bone must be divided with strong scissors or a very fine saw. Whichever is used, care should be taken to apply it above the level of the tooth-sacs.

Dr. Rawdon (*Brit. Med. Journ.*, 1883, vol. ii. p. 724) advises that this bone should never be interfered with if the two halves of the lip can be brought together over the projection without tension, as (1) the curing of the hare-lip is sufficient to diminish the gap and depress the projection, and as (2) by interfering with it a low condition of septicæmia may be set up. Dr. Rawdon's advice should be carefully followed. The bone can almost always be forced into place, without any cutting, at the early age at which cases of hare-lip are usually operated upon. And the danger of septicæmia in a wound which cannot be kept aseptic is not a remote one in an infant of low vitality.

The edges of the cleft are now pared. This, the most important part of the whole operation, must be done carefully, and thoroughly as well. The surgeon seizes the lower angle of each flap alternately, either with his left forefinger and thumb, or, if the parts are very small and slippery, with tenaculum-forceps, which should not hold the soft parts too near the edge, or they will tear out too soon. The edges being thus made tense, the surgeon with a narrow-bladed, small knife pares them as widely as possible by two incisions, beginning above at the upper angle of the cleft, curving outwards somewhat as they descend, quite clear of the edges of the fissure, and then, in the lower part, curving inwards again, through the red prolabium. Beginners nearly always make the mistake (Fig. 141) of removing only a thin paring of red surface. The pared surfaces should be made as wide as possible, especially below, in order that the sutures may hold better and the lip be deeper. If one margin of the flap is longer than the other, this should be pared first, and after this its fellow, that both may correspond. During this paring, hæmorrhage must be prevented either by the assistant who compresses the facial while he supports the head, or by an assistant compressing the coronary artery between his finger and thumb at the corner of the mouth, or by hare-lip clamps placed at the corners of the mouth.

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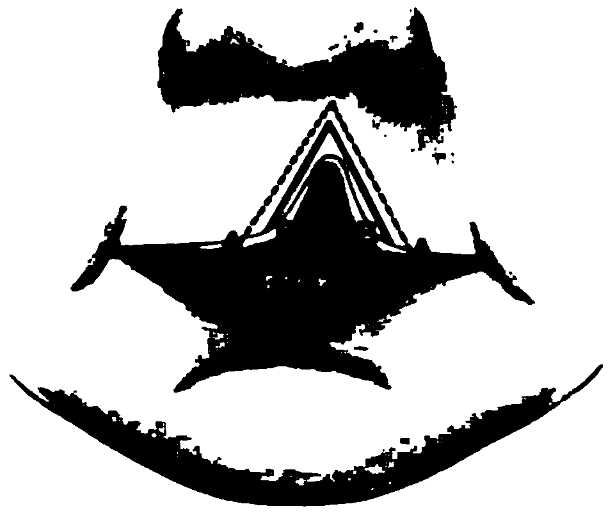
* If the back of the child's head is firmly supported, the thumb of the surgeon will, usually, quickly fracture back the bone into place.

The assistant who steadies the head and keeps pressure on the facial arteries, now, with two fingers, presses the cheeks together, so as to bring the flaps into apposition while the surgeon introduces his sutures. I much prefer for these, first, one or two of stout well-soaked salmon-gut, the lower to command the coronary arteries, and passed close to the mucous membrane. If one flap is still shorter than the other, this stitch may be passed through the opposite side from below upwards, then entered on the shorter side at a point a little higher than that at which is left its fellow, and passed from above downwards so as to tilt down the margin which is the higher, and bring it level with the other.

FIG. 141.



(After Whitson, *Edin. Med. Journ.*, 1883, p. 7.)

The dotted line shows the cleft widely and freely pared. The dark one shows timid paring close to the prolabium. The advantages of the first incision are—(1) A broader lip. (2) Firmer union, as a greater number of vascular points are cut which will throw loops across. (3) A better grasp for the sutures. (4) A more vertical depth to the lip, the two points, A, A, being on a lower level than B, B. The lower ends of the dotted lines should have been shown curved downwards and inwards in the usual way.

This first stitch being passed, and the chief fear of bleeding removed, three or four others of finer gut or horsehair* are inserted, one being placed in the free margin of the lip to keep the wound carefully closed here against the entrance of milk, saliva, &c. In adjusting the top stitch care must be taken that it does not too much depress the tip of the nose, if the cleft has been one running up into the nostril. All the chief stitches should be inserted with very fine needles, one-third of an inch from either side of the cleft.

It will be gathered from the above that I do not advise the use of hare-lip pins. They are useful, no doubt, in promoting close and accurate union where the parts come together easily, but at the expense of the risk of sloughing and scars even here; where tension is considerable, this risk is very much increased. The surgeon will, I think, do more wisely who adopts the sutures already described, preventing tension by freely separating the soft parts from the bone. If pins are used they should be far slenderer than those usually sold; the first should be inserted low down so as to command the coronary arteries, and, if one side of the cleft is shorter than its fellow, the pin should be passed so as to draw it down, in the manner already described. The pins must be removed at the end of forty-eight hours, or scar-points will be left. And in feeble children the above time is too short for firm union to have taken place.

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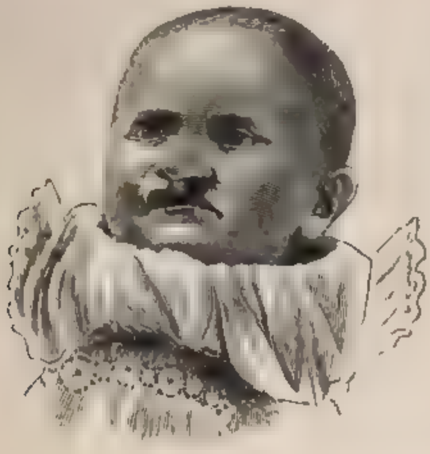
* Silk should not be used, from its tendency to become septic here.

The sutures being tied, the nostrils are cleared of any clots, some iodoform and collodion[*] are painted on evenly over the wound, and the following dressing applied:

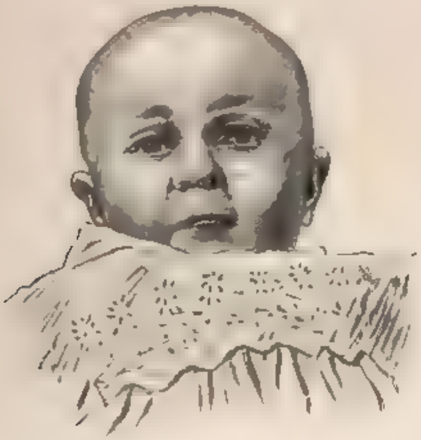
A piece of iodoform or sal alembroth gauze two layers thick should be cut before of appropriate size and of butterfly shape, so that one wing can be fixed upon each cheek, while the uniting portion, just

FIG. 142.



Single hare-lip, with wide cleft, the two sides widely divergent and not on the same level.

FIG. 143.



The same case, three weeks after operation. The lip is broad and deep, and the red line level. The septum is still a little dragged down. The patient was a healthy country infant, with a devoted mother, sent me by Dr Roland Cox, of Kintbury, Hungerford. Both this and Fig. 142 are from photographs.

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[*] The collodion will not only help to hold the parts together, but will prevent milk, saliva, &c., from getting between the flaps.

the width of the lip, passes over the wound. This dressing is secured in place with collodion, and, while it is being adjusted, an assistant holds the cheeks forwards, a position which must be maintained until the collodion is firm. For this most useful dressing, which keeps the parts together and protects them from saliva, &c., I am indebted to Mr. Rose (*Hare-lip and Cleft Palate*, p. 84). It is as efficient as it is simple.

In the after-treatment, the wound may be looked at on the second or third day, the stoutest salmon-gut or silver wire removed on the fourth day, and the others left in much longer. A camel's-hair brush is the best way of cleansing the wound. On each occasion the cheeks must be most carefully supported, while a similar dressing to that described above is applied.

One point of great importance is not alluded to in surgical works, and that is, that in some cases of hare-lip death from dyspnœa may take place very soon after the operation. Thus, where the cleft has been a large one, and the upper lip when restored is tight, when it overhangs the lower, if the nostrils are flattened and partially closed by the operation, owing to the tension of the parts, so little breathing space may be left that temporary interference with respiration may occur, with grave and even fatal results before the breathing can be accommodated to the altered circumstances, and before the parts dilate and stretch.

The first case that drew my attention to this accident occurred in the early part of 1887, at Guy's Hospital. I had operated on an infant, aged three months, having a large cleft with unequal sides and going through the alveolar margin, the two halves of these being on different levels. The projecting alveolus was broken back into position, pared, and stitched with chromic catgut to its fellow. The edges of the cleft were then pared and united. They came together excellently, the wide cleft being replaced by a deep upper lip. One nostril was rather chink-like. About half an hour after, whilst I was engaged in another operation, a message came that the child was livid and dying. I had the child at once brought to me in the theatre; the strapping was removed, the tongue carefully drawn forward, and artificial respiration performed. The child quickly came to and began to cry, though not very vigorously. Three-quarters of an hour later its breathing again failed, and, though Mr. Wacher, the senior house-surgeon, at once repeated the artificial respiration, he was unable to resuscitate the child. At the necropsy no clot was found in the fauces, nor anything wrong beyond the suddenly occluded oral passage.

I find that my old friend G. A. Wright,* of Manchester, has recorded two such cases:

The children here were aged three and five weeks respectively, the hare-lips double; in one, after the operation, the lower lip was drawn in so much as to leave but a small opening, but there was not apparently any dyspnœa. In one case dyspnœa came on suddenly, and, as no relief followed on pulling the tongue out, tracheotomy and artificial respiration were performed. The child came round, but a few hours later the breathing failed again, and death ensued. In the second case, the child was found dead in the night. "The cause of death was probably valve-action of the lower lip."

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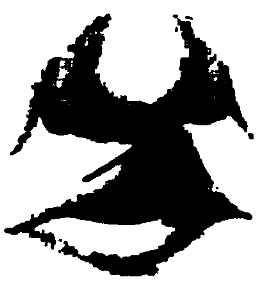
* *Abstracts of Cases treated at the Pendlebury Hospital*, 1885, p. 146. In his *Abstracts* for 1883, Mr. Wright records a case in which, after an operation for hare-lip, there was so much dyspnœa, from the tongue clinging to the roof of the mouth at each inspiration, "that it had to be pulled out and fastened by a ligature."

Mr. Rose (*loc. supra cit.*, p. 85) draws attention to the need of the nurse depressing the lower lip frequently with the index finger, or by painting on a strip of collodion between the lip and the chin, until the child has become accustomed to the diminished oral aperture, otherwise the efforts to draw air through the closed mouth will tend to disturb the wounded surfaces.

In a few cases of hare-lip where the divergence is great, and where the sides of the cleft are very unequal, the following operations may be made use of, but it will be found that, on the whole, the first-mentioned is not only the quickest performed, but also gives the best results in the largest number of cases, as long as the flaps have been freely separated from the jaws and the edges broadly pared. Operations for hare-lip are not common enough to give every surgeon a large individual experience in this special line. As the one that I have first described is that best adapted to the largest number of cases, I advise my younger readers to attain skill by practising it on every occasion.

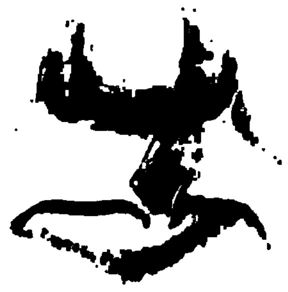
(ii.) **Operation of Clémot* or Malgaigne** (Figs. 144, 145). The edges are pared down to, but not beyond, the red lines; the flaps thus detached above are turned downwards and kept out of the cleft with a probe. The upper part of the cleft is then sewn together with the sutures already advised, while the projecting point is shortened as required with a pair of sharp scissors and united with one or two points of horsehair. The chief objection to this method is, that, unless great care is taken, a little skin, imperceptible at first, but showing white after a time, may remain below the red line, or as a break in it. Again, the projection is very liable to get in the way during feeding.

Fig. 144.



(Nélaton.)

Fig. 145.



(Nélaton.)

Where the divergence is more marked, and the sides of the cleft very unequal, the following may be made use of.

(iii.) **Method of Mirault** (Figs. 146, 147).—On the side which is the more vertical of the two an incision is to be made downwards and outwards from the apex of the cleft to the junction of skin and mucous membrane, so as to leave a flap on this side free above, but attached below. The other, more sloping, side is then freely pared throughout its extent from the apex downwards and outwards. Any adhesions of the lips to the gums being then thoroughly separated, the flap is brought across and attached to the pared opposite side with the sutures already mentioned.

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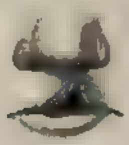
* M. Nélaton (*Pathol. Chirurg.*, t. iv. p. [illegible]) states that M. Malgaigne was anticipated by M. Clémot, of Rochefort.

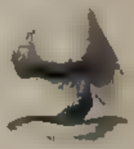
If this method be made use of, the flap must not be a mere paring, but cut as thick and succulent as possible, and the opposite side must be thoroughly and widely refreshed.

FIG. 146.*



Nélaton.)

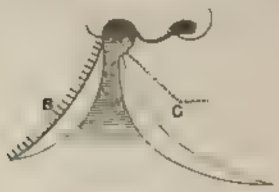
FIG. 147.



(Nélaton.)

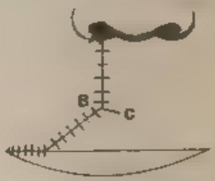
Figs. 148 and 149 show a modification of the above, introduced by Mr. E. Owen (*Lancet*, 1887, vol. ii. p. 361). The right lip is first widely pared. To free the flap which is to be brought across from the left side, the incision is first made as usual from A to C, and then outwards. The object of this outward prolongation is to enable the flap to lie level smoothly when it is brought over—*i.e.*, without kinking, to which there is otherwise a tendency.

FIG. 148.



(Owen.)

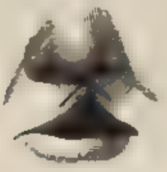
FIG. 149.



(Owen.)

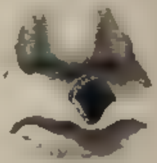
(iv.) **Method of Nélaton** (Figs. 150, 151).—This gives another means of substituting a protuberance for the cleft. An incision resembling a V reversed is made around the upper angle of the cleft. By this means the red edge of the cleft is separated from the two halves of the lip, except at each corner below. This red edge is next turned downwards, or reversed so that the ʌ-shaped wound becomes diamond-shaped. The bleeding surfaces are then brought together by the means already given.

FIG. 150.



(Nélaton.)

FIG. 151.



(Nélaton.)

Mr. Holmes (*loc. infra cit.*) considers that Nélaton's operation is peculiarly adapted to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril These instances are rare, but Mr. Holmes further points out that in cases where an unsightly notch is left behind, if there be not much cicatrisation around the incision, the deformity may be almost certainly remedied by this operation.

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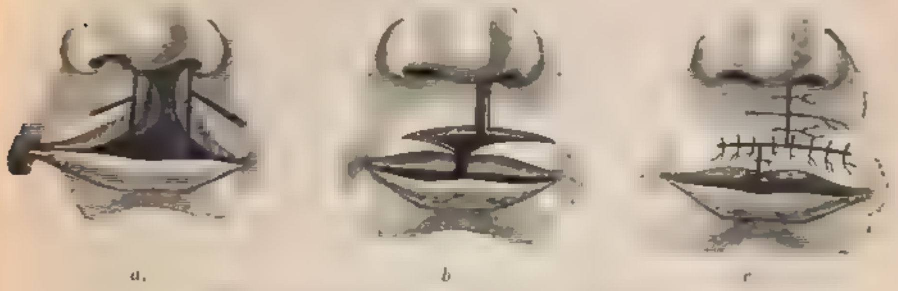
* The sides, especially the one which is refreshed throughout its whole extent, should be pared as in Fig. 147—that is, somewhat angularly—so as to promote the adjustment of the flaps, as it were by interlocking.

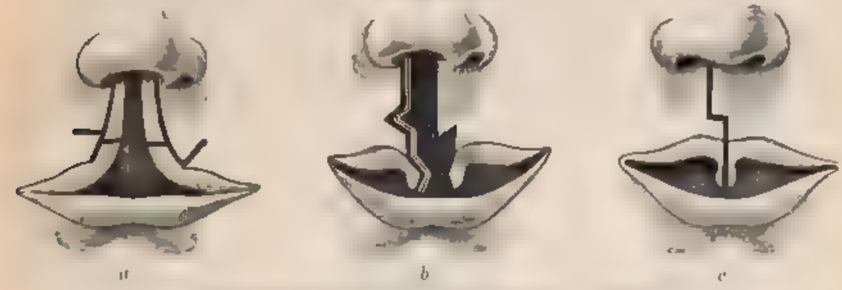
Fig. 152



König's operation for single hare-lip (Tillmanns.)

The operations of König and Hagedorn are explained by the figures which illustrate them.

Fig. 153.



Hagedorn's operation for single hare-lip. (Tillmanns.)

Occasionally, after an operation for hare-lip, the new lip is too small and the lower one unduly prominent, conditions sometimes inseparable from operations upon wide clefts. If this deformity prove likely to be permanent, it may be remedied later on by taking a wedge from the lower lip and careful adjustment of the gap (Owen, *Surgical Diseases of Children*, third edit. p. 227).

DOUBLE HARE-LIP (Figs. 154, 155, 156).

This is often easier of cure than single hare-lip with very divergent sides and the alveolar margin cleft and its two parts on unequal levels. For in double hare-lip the mischief is often symmetrical, and the sides less divergent.

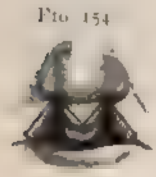
Sir T. Smith (*loc. supra cit.*, p. 799) gives the three following varieties of hare-lip which are met with here and which are of practical importance:

(α) When the pre-maxillary bone is *in situ*, and the two clefts are simple and fairly bilateral.
(β) When the pre-maxillary bone is separated from the rest of the jaw and projects forwards, in some cases slightly, in others being attached to the vomer and hanging from the tip of the nose.
(γ) When the pre-maxillary bone is small and ill-developed, and when the clefts are widely gaping.

The first two of these require notice.

(α) If the pre-maxillary bone is in proper position, the skin over it is freed from its attachments behind and pared to a point. The sides of the cleft are next pared from above downwards (as in Figs. 141, 154), and the parts brought together by transfixing the sides and the central flap with a silver wire suture, every care being taken to keep the central piece well down. Horsehair and salmon-gut sutures are also used as well. As the central piece is always shorter than the lip itself, the resulting wound is Y-shaped, and it is the side flaps which meet each other in the middle line below. Care must be taken to free the central flap right up to the nose, and not to depress it too much with the sutures, otherwise the nose will be flattened.

Fig. 154.

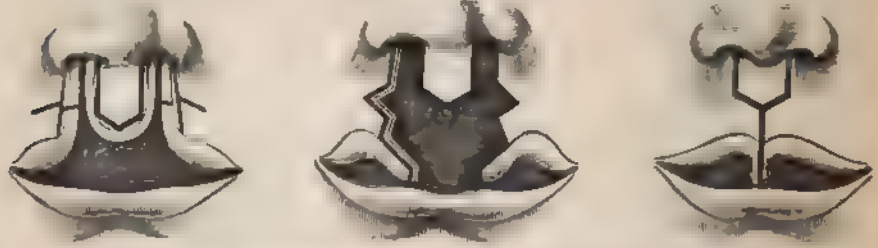


(Nelaton.)

(β) Cases in which the pre-maxillary bone is separated from the maxillæ, projecting forwards, sometimes being even attached to the very tip of the nose.

The question of removing or leaving the pre-maxillary bone arises here, and the very best authorities have differed widely. Many have advised its removal, if it projected much, because (1) pressing it back is difficult and unsatisfactory; (2) if it be pressed back, it rarely unites by bone; (3) in such a case it will act as a wedge, preventing closure of the alveolar arch and palate-fissure; (4) the teeth in it (the central incisors) cannot be relied upon to come through usefully; and (5) a dentist can fit a plate that will answer the purpose quite as well. On the other side, Mr. Holmes* argues thus: "It is of the highest importance to preserve, if possible, this portion of bone, for these reasons: (1) if the bone be removed there must be a permanent gap through the hard

Fig. 155.



Hagedorn's operation for double hare lip.

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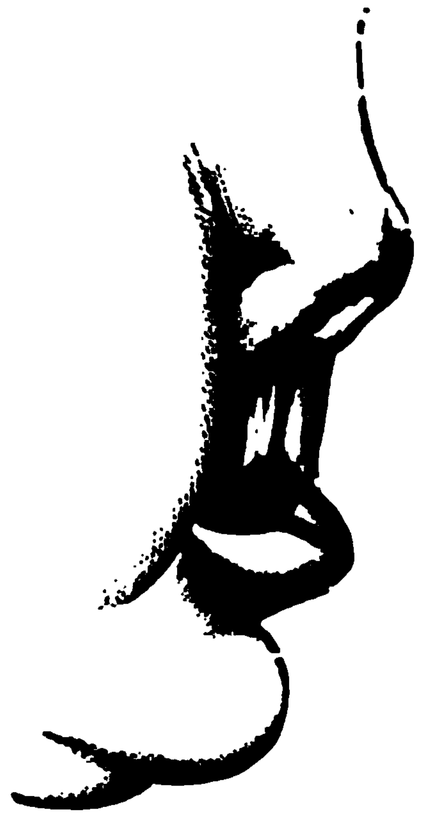
* *Surg. Dis. of Children*, p. 108.

palate. (2) There must also be a flattening and malposition of the upper lip, in consequence of its having lost its bony support; and from this flattening of the upper jaw it will result that the lip will be very short and tense, and the patient extremely 'under-hung,' a very unpleasing deformity" (Fig. 156). To this I would add two more—that (3) the presence of this bone is needful for the preservation of the due width and arch of the bone, and (4) that such an arch will best carry artificial teeth, if any are needed owing to the unsatisfactory eruption of the natural ones. Thus most surgeons will prefer to follow Mr. Holmes' advice. Mr. Holmes, a little later, goes on to say that in a few cases it may be necessary to sacrifice the bone—*e.g.*, where it is very far forward, very much out of proportion to the neighbouring parts, and the child very weak.

FIG. 156.



(Holmes.)

I am of opinion that, if the following points be attended to, the pre-maxillary bone, however advanced and firmly based, can be replaced and preserved; weakness on the part of the child, which is undoubtedly a matter of grave consideration in cases like this where the loss of blood is considerable, is best met by doing the operation in two stages—in other words, being content to first get this bone replaced, and leaving the uniting of the soft parts till another time.

Where the stalk of attachment of the pre-maxillary bone is slender, and where there is plenty of room between the two maxillæ, it may often be broken back into place by the operator supporting with his left hand the back of the child's head, and then with his right thumb sharply fracturing back the bone. This should be done thoroughly, and, if needful, by the aid of non-serrated forceps covered with drainage-tube, or bone-forceps may be applied to the stalk in front and also behind till it is almost completely cut through. If now it can be replaced, but tends to come forward again, it should be sutured, on one side at least, to the maxillæ with chromic catgut or carbolised silk, or wire.

If the maxillary bones on one side or both are in the way, and prevent the replacing of the pre-maxillary bone after it has been detached sufficiently, or if this is too voluminous, its sides must be cut away and the maxillæ also pared till the central piece can be pushed back between them and retained with a suture, as above advised.

A severer method—one, therefore, which should only be tried when all other means of replacing the pre-maxillary bone have failed—is to cut a wedge-shaped gap out of the septum nasi and to press or fracture the partially detached bone into the gap. Some have passed a suture* through the septum before the wedge is cut out, and then united the ends over the pre-maxillary bone to keep it in place.

The hæmorrhage may be very free in these cases where very vascular bones are cut through. I have generally found that it is at once arrested by suturing the bones, but in some cases it may be needful to apply a fine point of actual cautery or of the thermo-cautère; if this has been necessary, and if the child is very weakly, septicæmia may easily follow.

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* If he do this the surgeon must be provided with needles of different curves. Small curved ones in a holder offer more variety than those in handles.

No cutting is to be employed here, if it can possibly be avoided. The objections to this step are given at p. 407.

It is absolutely necessary, by some means or other, to get the premaxillary bone quite back and to make it stay there, as otherwise the soft parts over the projecting bone, or the line of union, which often comes just opposite to it, will be pressed upon and give way.

So, where the surgeon is unable to get the bone back by any method, he may follow the advice of Sir W. Fergusson,* and, incising the mucous membrane over the bone, separate this sufficiently to introduce a small gouge about a quarter of an inch broad, scoop out the temporary incisors, and cut away the wall of bone, which for the first eight weeks consists of merely a few plates. By this the projection is removed, and the tissues which remain offer no obstruction to the union of the lip in front. Only the mucous membrane and some periosteum are left to form a soft cushion behind the united lip.† Furthermore, by this means the loss of blood is diminished.

Causes of Failure and Death after Hare-lip Operations.—Amongst the commonest of these are—(1) Feeble vitality. Marasmus. Many infants die after hare-lip operations, but, while the effect of loss of blood and of pain must not be lost sight of, in most of the fatal cases death is due, not to the operation, but to feeble vitality. Whether operated on or not, the majority of these cases would have died in infancy. (2) Hæmorrhage. This, if serious, is due either to very free separation of the flaps in a weakly child, or (a cause much less excusable) to the coronary arteries not having been properly secured. Loss of blood will lead to non-union, but it may destroy life rapidly by a clot in the fauces and upper aperture of the larynx. One case has come to my knowledge in which, after operation, this untoward result would have happened, the child getting increasingly blue and breathless, had it not been for the prompt common-sense of the nurse in charge, who fished out a large clot with a sponge on a holder. (3) Bronchitis and broncho-pneumonia. (4) Diarrhœa. (5) Asphyxia (p. 410). (6) A low septic condition, especially where the bone has been interfered with in a weakly infant, and under conditions always adverse to aseptic healing.

Repetition of Operation.—I may remind my younger readers that in many cases a perfect result cannot be secured by one operation. Where parents are likely to be unreasoning and unreasonable, the surgeon should warn them of this.

In cases unfavourable owing to the malformation or to the general condition (p. 406), hare-lips which have been operated on often cause disappointment, however much, up to the third day, they resemble pictures in books. Incomplete closure, below or above, a little inequality in the levels of the halves of the new lip, some flattening and closure of the nostrils—any of these may mar the first operation. The more operations a surgeon does, the more difficult and trying cases will he meet with. He can scarcely do better than remember the words of the great surgeon of Vienna (Billroth, *Clin. Surg.*, p. 79): "Operations on little children do not always succeed as well as could be wished, on account of the diminutive size and softness of the parts. The flaps of the lips cannot always be adapted as exactly as desired, and, even if this be satisfactorily accomplished, the result does not in every case quite come up to expectation, so that, some few years after, further slight proceedings become desirable, in order to improve the appearance." And again, a little later, the same surgeon, speaking of operations on "quite little children," says: "I decline to give any absolute guarantee with regard to the result in such cases."

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* *Brit. Med. Journ., loc. supra cit.*

† This cushion can be stitched to the maxillæ, if needful.

OTHER PLASTIC OPERATIONS ON THE LIPS AND FACE

(Figs. 157 to 178).

These are very numerous, especially for the restoration of the lower lip after operations for epithelioma, &c., injuries, ulcerations, and burns. A few of the chief will be described here.

It will be convenient if, at this time, I add some general principles which should govern every operation of plastic surgery, large or small.

(1.) The patient should be in the best possible condition as to general vitality, healthy performance of the chief functions, appetite, &c.

(2.) If the deformity has resulted from tubercle or syphilis, a satisfactory condition, both constitutionally and locally, must have been secured by previous treatment. And it may be well, sometimes, to continue constitutional treatment after the operation.

(3.) The parts to be operated upon must be rendered as aseptic as possible. Where the mouth is involved, this and the teeth should be thoroughly cleansed beforehand.

(4.) Asepsis should be maintained as thoroughly as possible throughout the operation.

(5.) The flaps should be taken from healthy parts. "Under no consideration should cicatricial tissue of a pale glossy surface be employed, for when its subcutaneous connections are severed it is almost certain to slough, especially when the result of a burn. If cicatricial tissue exist at the base of a flap, sloughing is quite likely to occur. Cicatricial tissue at the border of a flap is quite certain to die, and its presence there must not be estimated in computing the area of the new flap. When the flap is to be joined on three sides with cicatricial formation, the base must be made large, be highly vascular, and but little twisted, as the vascular supply at the sides will be very little added to by the new association" (J. D. Bryant, *Oper. Surg.*, vol. i. p. 507).

(6.) Each flap must be cut thick enough, carrying with it the subcutaneous tissue, and large enough; "as a rule, one-sixth larger than the space it has to fill" (Treves, *Operat. Surg.*, vol. ii. p. 3). "Reparative flaps should always be made large enough to allow of at least three lines of shrinkage for each inch of width of their surface" (J. D. Bryant, *loc. supra cit.*).

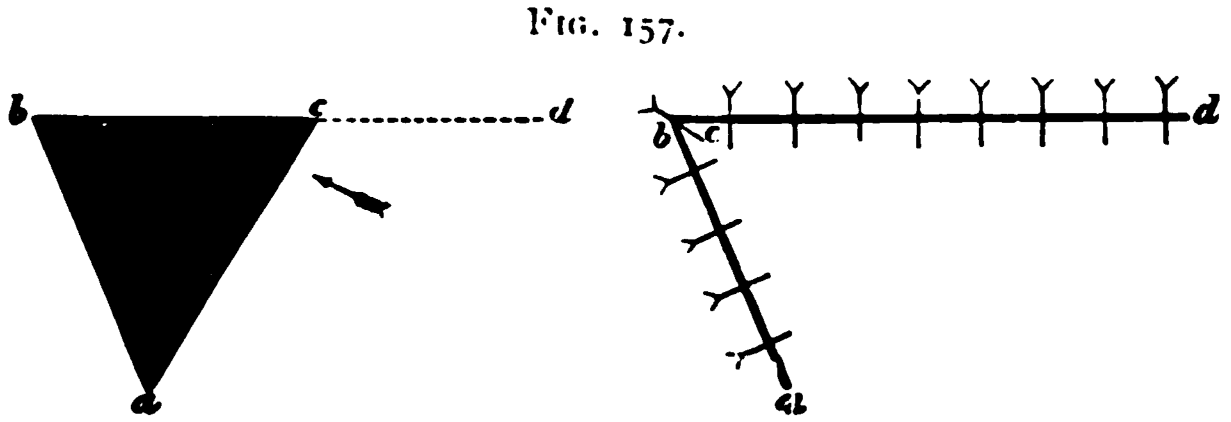
(7.) There must be no tension whatever on the flaps when they are brought into apposition. Tension is one of the most frequent causes of failure after a plastic operation. The chief aids in securing this most important end are: (*a*) *Cutting the flaps sufficiently large.* (*β*) *Under-*

27

mining the flap or flaps. Julius Wolff elaborated this method of closing large gaps (*Berl. Klin. Woch.*, 1890, No. 6). It is thus described by Messrs. Watson Cheyne and Burghard (*Man. of Surg. Treat.*, vol. i. p. 178):—"In small wounds the knife is carried between the superficial fat and the deep fascia; in extensive ones it should be swept between the deep fascia and the muscles, and by this means the skin and fascia are raised from the deeper parts for a considerable distance around the wound. The undermining should be carried on until the edges of the wound can easily be brought into contact by pulling upon them. In raising these flaps great care must be taken to direct the edge of the knife towards the deeper parts, and not towards the skin: failure to observe this precaution is apt to result in scoring of the flap, and as the blood-vessels which supply the skin ramify in the subcutaneous fat, the blood-supply to the edges of the wound might be cut off, and sloughing might ensue. The freeing of the edges of the wound by undermining must be carried out sufficiently widely to allow them to come together without endangering the circulation in the flaps. If it has not been done sufficiently freely, the flaps will become white on putting in the stitches, and after waiting a little the circulation will not be restored; it will therefore be necessary, in such a case, to carry the undermining further, when the flaps may be brought together without being permanently blanched. If at first there be a little whiteness in the immediate vicinity of the stitch, it will disappear in a few minutes when the tension is not too great." (γ) By making *liberating incisions* at a short distance from the wound, lateral or horizontal as required, before inserting the sutures in the lips of the wound. These incisions cause slightly gaping wounds after the defect has been closed, but these usually heal rapidly by aseptic granulation. (δ) By the use of *flaps*. These may be (1) *broad and glided*, or (2) *pedunculated and jumped*.

(1) Fig. 157 shows how a triangular gap may be closed by gliding in a flap raised by a horizontal incision. But in these cases it is preferable to convert the horizontal incision *c d* into one curving outwards

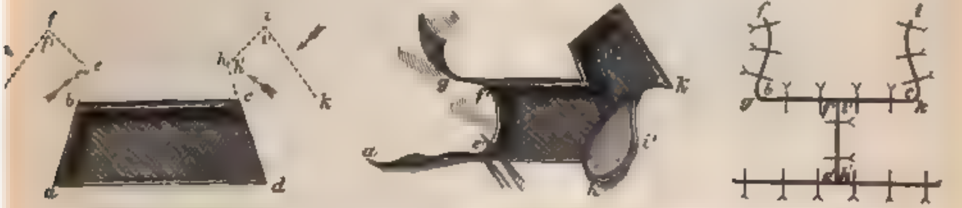
Fig. 157.



and downwards. Such an incision better frees the flap *a c d*, which to be glided, and is likely to leave a less conspicuous scar, as it often be made to follow a natural sulcus. Where the gap is very la two such freely curved incisions are made, one on each side of the In the removal of extensive epitheliomata of the lower lip, whe very large triangular gap is left, such freely-made curved flaps enable the surgeon to close the gap better than those which authoritative names and which are shown below (Fig. 165). curved incisions should pass outwards from the corners of the m downwards through the whole thickness of the cheek, and then across the jaw into the sub-maxillary regions, finally curving inwards towards the hyoid bone. Drainage must be provided by counter-punctures where the flaps are large.

(2) Flaps with pedicles.—These may be so fashioned (as in Fig. 158, where a quadrangular gap is being closed) that the flaps are again little more than glided, there being no intervening undetached soft parts over which the flaps are "jumped."

Fig. 158.

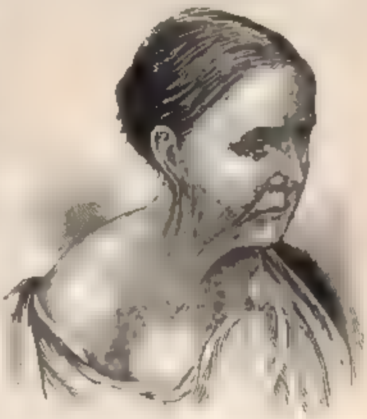


Bruns's method of closure of a quadrilateral gap by two lateral flaps (Tillmanns.)

In rhinoplasty (p. 354) the flap is sometimes moved by "jumping"—*i.e.*, carried over intervening undetached tissues.

(ε) One more class of flaps must be mentioned, that of *granulating flaps.* This method has been used with much success especially in cases of cicatrices after burns, by Mr. J. Croft (*Med.-Chir. Trans.*, vol. lxxii., 1889, p. 349). Where the gap is a large one, the flaps being necessarily long and somewhat narrow, and therefore possessing but a limited blood-supply, Mr. Croft advises that the flaps be dissected up and left attached at each end, and allowed, together with the wound, to granulate before the flap is moved. Mr. Croft claimed the following advantages for this method, and his claims were made good by the cases which he showed: 1. The risks of sloughing of any part are greatly diminished. Instead of being transplanted when recently drained of blood and reduced in temperature, it is moved when abundantly vascular and full of active, living, plastic matter. 2. The transplantation being made two or three weeks after the first operation, the local effects of shock are avoided or reduced to a minimum.

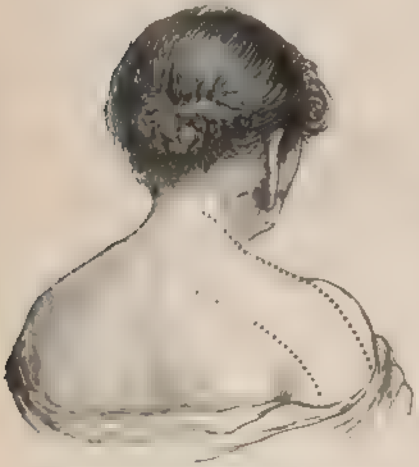
Fig. 159.



Patient before operation (Croft.)

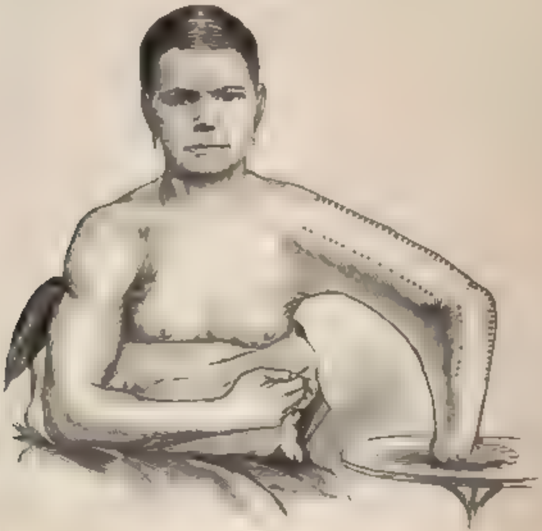
The skin having been carefully sterilised, long lateral incisions are made down to the deep fascia, and then the flap, usually strap-like in shape, is carefully undermined throughout and completely separated from the deep fascia. It is cut uniformly and as thick as possible, especially in its centre. It may have to be from 8 to 9 inches long and 3 inches wide. A piece of green protective which has been lying in carbolic acid (1 in 20) or sublimate solution (1 in 2000) is then placed between the flap and the bed from which it has been raised, and this, renewed as needed, is kept *in situ* for fourteen or twenty-one days. At the end of this time the scar is freely divided from end to end into healthy tissues, and its edges dissected up above and below. The flap, which will now have become shorter and narrower and loaded with plastic material, is cut across at its distal end; it is next trimmed and pared to a certain extent by freshening its edges and its under surface for nearly or quite half of its extent, then transplanted into the wound, and carefully sutured with well-sterilised salmon-gut and horsehair. If the free end of the strap-like flap die, then the whole flap will begin to contract and retract, but sufficient union will probably take place to anchor it in satisfactory position. If necessary, the flap must be kept in place by strips of iodoform gauze wrung out of 2 per cent. lysol solution, and fastened by iodoform and collodion. "A stranger to this mode of operating would have been very disappointed at the appearance

FIG. 160.



The same patient five years after operation. The dotted lines show the site and extent of the strap of skin which was raised and transplanted. (Croft.)

FIG. 161.

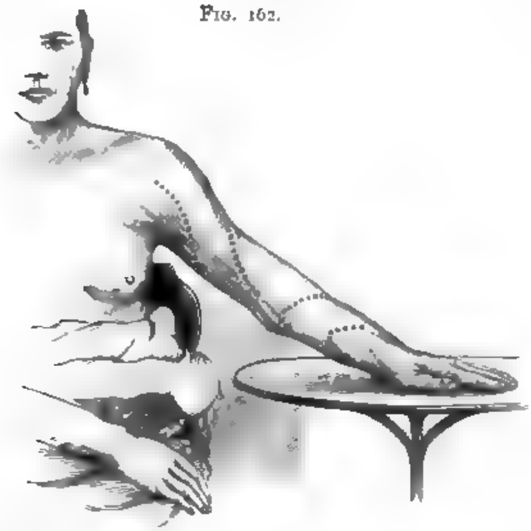


The patient before operation. The web is well shown. The dotted lines indicate where the strap-like flaps of skin were raised and their extent. (Croft.)

of the parts at the completion of the operation, as the transplant looked so thick, clumsy, and narrow, and a considerable part of the fresh wound remained uncovered by flap." Again, "At first the transplant looks very ungainly, unsightly, and unpromising. As week after week goes by, the sausage-like thing flattens down and spreads out, until, finally, it may become twice as wide as it was originally cut."

While Mr. Croft's results abundantly justify a resort to this method, it is a tedious one, nine to twelve months being sometimes needed in a severe case; it is a painful one, as the second stage may have to be repeated; and it draws largely on the reparative powers of the patient.

Fig. 162.



After operation. The greatly improved position of the limb is manifest. The dotted lines show the situation into which the flaps have settled. (Croft.)

For these reasons most surgeons will prefer to try, first, what can be effected by a very free division of the scar and then careful Thiersch's grafting (p. 188).

(8.) All hæmorrhage must be thoroughly arrested; any catgut ligatures used must be of the finest.

(9.) Each flap "must be gently handled, carefully adjusted, and most tenderly and precisely sutured" (Treves, *Oper. Surg.*, vol. ii. p. 3).

(10.) The sutures, of sterilised salmon-gut and horsehair, must be inserted so as to uniformly distribute the slightest remaining tension.

(11.) Asepsis must be carefully maintained during the healing of the wound.

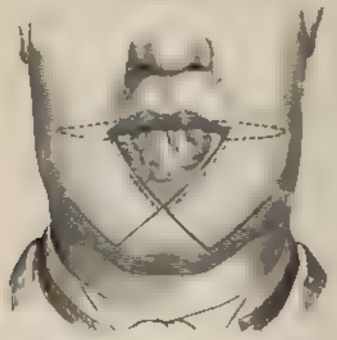
(12.) Where restlessness on the part of the patient is to be expected, as in a child with one of the common burn-scars on the neck or upper extremity, some fixed apparatus should be kept applied, from the first, to the head and neck, upper trunk and limb, or the flap will begin to ulcerate and irreparable mischief will be done.

Lower Lip.

(i.) **Method of Serre** (Fig. 163).—Where a growth implicates the whole of the lower lip, but does not extend far down upon the chin, this operation gives excellent results. If the angles of the mouth are also involved, the operation consists practically in removing three triangular portions of soft parts, as shown in the dotted lines in Fig. 163. Two of these have their apices on the cheeks, and their bases at the angles of the mouth, while the central triangle has its apex downwards towards the chin, and its base turned upwards to the mouth.

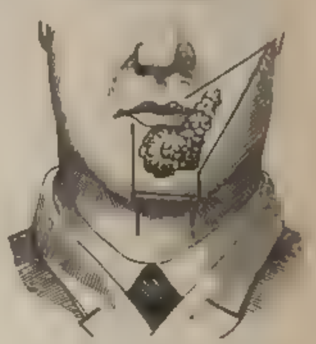
If the angles are not involved, straight incisions, and not triangular ones, may be made out on to the cheeks, while, if needful, the apex of the central can be carried down on to the chin, or even on to the neck, some further incisions being usually required in such a case, viz., curving outwards laterally from the apex along the jaw or in the submaxillary region, as in Fig. 163. The flaps are united with silver wire, salmon-gut, and horsehair; a few fine hare-lip pins being used, if needful, to overcome tension. The sutures should be put in sufficiently close to distribute any tension evenly, and the chief ones should be one-third of an inch from the edges of the wound, and should be passed close to the mucous membrane. As far as practicable, bleeding points should be commanded by sutures, and torsion or ligatures dispensed with as far as possible. Any pins used should be removed on the second or third day, and the sutures one or two at a time. Iodoform and collodion is as good an application as any.

FIG. 163.



The dotted lines show the operation of Serre, the continuous ones that of Syme. The central part of each runs too near to the growth.

FIG. 164.*



The quadrangular incisions on the chin will indicate the method of Chopart. The triangular incisions show how a growth at the corner of the mouth may be dealt with. (After Serre.)

(ii.) **Method of Syme**† (Fig. 163).—This operation leaves the central and prominent part of the chin undisturbed, two lateral flaps supplying the defect.

Supposing the whole lower lip affected, the growth is removed by two incisions passing from the angles of the mouth to the prominence of the chin. Bleeding points being compressed by assistants, the surgeon makes two incisions from the apex of his first, passing at first straight downwards and outwards, and then curving outwards and upwards, so as to free two large lateral flaps, which are dissected up as thick as possible and united in the manner already described. The first part of the two lateral incisions—viz., those passing downwards and outwards—meets in the middle line to form the new lip. This is supported by the prominence of the chin, which retains its natural connections. The lower and more curved parts of the incision must be carried outwards towards the angles of the jaw in order to allow the flaps to come into position readily and without tension, and without leaving gaps to granulate.

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* This and the next two figures are taken from M. Serre's atlas accompanying his *Traité sur l'Art de Restaurer les Difformités de la Face selon la Méthode par Déplacement*, Montpellier, 1842.

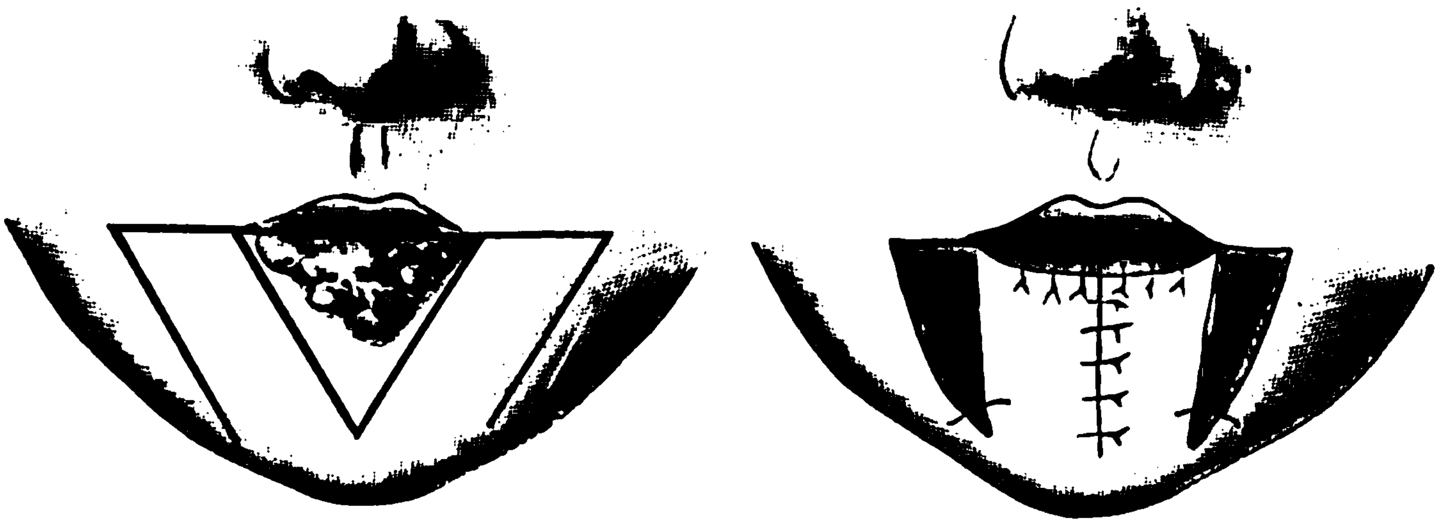
† *Observ. in Clin. Surg.*, p. 60.

(iii.) **Method of Buchanan.**—This is planned on the same lines as that of Prof. Syme. The growth is removed, here, by an elliptical incision. From the centre of this two incisions are made, first downwards and a little outwards, and then from the ends of these two curving outwards and upwards, much as in Prof. Syme's operation. When flaps thus marked out are detached and raised, the elliptical incision becomes horizontal and forms the new lower lip.

Both in this and Prof. Syme's operation, when the gap is very large or the soft parts scanty, two small triangular gaps may be left below. These will heal by granulation, promoted by skin-grafting.

(iv.) **Method of Chopart** (Fig. 164).—The growth is removed by a quadrangular incision, the upper margin being formed by the lip, the lower by an incision parallel with it across the chin, and at the sides by two vertical lines dropping down over and below the jaw. A square-shaped flap is then dissected up from below, and brought up to form the lower lip. The weak point is that, in spite of keeping the head flexed, the flap tends to sink down. This might be, in part, prevented by freeing the flap more completely by carrying out into the sub-maxillary regions lateral incisions curving outwards and upwards from the ends of the vertical ones.

FIG. 165.

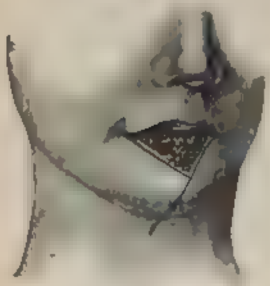


Dieffenbach's method of cheiloplasty. (Esmarch and Kowalzig.)

(v.) **Method of Dieffenbach** (Fig. 165).—After the usual wedge-shaped excision of the diseased lower lip, incisions are carried out horizontally from the angles of the mouth through the whole thickness of the cheek, and from the ends of these oblique incisions are made parallel with the edges of the wound. The rhomboid flaps thus formed are united in the centre, and Dieffenbach was careful to suture the mucous membrane to the skin on the edge of the new lip. This point is one of much importance for the comfort of the patient when fed, and, later on, for the prevention of undue contraction of the new mouth (Figs. 169, 170, 172). The gaps left on either side when the flaps have been sutured together may be partly closed by suture and skin-grafting, or, if small, left to heal by healthy granulation.

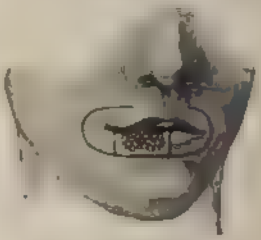
(vi.) **Method of Blasius** (Fig. 166).—This is well adapted to triangular defects, especially if placed to one side.

Fig. 166.



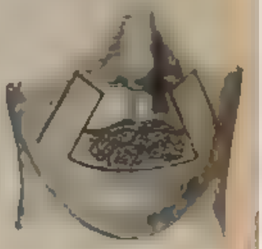
Blasius's method of cheiloplasty (Tillmanns.)

Fig. 167.



Langenbeck's method of cheiloplasty (Tillmanns.)

Fig. 168.



Cheiloplasty by the method of Brüns (Tillmanns.)

(vii.) **Method of Langenbeck** (Fig. 167).—This is adapted to gaps which have a somewhat quadrilateral shape.

(viii.) **Method of Brüns.**—As shown in Fig. 168, Brüns takes two flaps from the cheeks.

While I have given several methods here, because the condition of the soft parts in different cases may prevent any one method being followed, I consider that the one made by two free curved incisions (p. 418) is, on the whole, the best as securing the two chief ends of removal of the lower lip—(*a*) cutting wide of the disease; (*β*) bringing the parts together with a minimum of tension, and, very often, surprisingly little deformity. As will be seen in the preceding figures, the incisions are usually placed much too near to the disease. Great attention must be paid to the accurate suturing of skin and mucous membrane to form the new margin of the mouth, especially at its angles (Figs. 169, 170, and 172).

Restoration of Mouth.—This is sometimes required when extreme

Fig. 169.

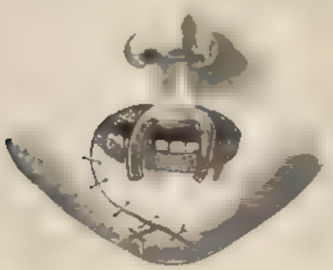
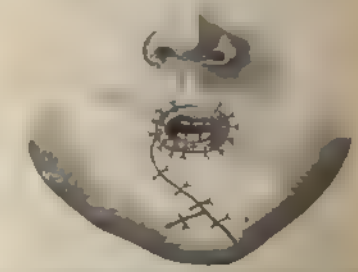


Fig. 170.



Utilisation of red margin of upper lip for the restoration of the angle of the mouth (Esmarch and Kowalzig.)

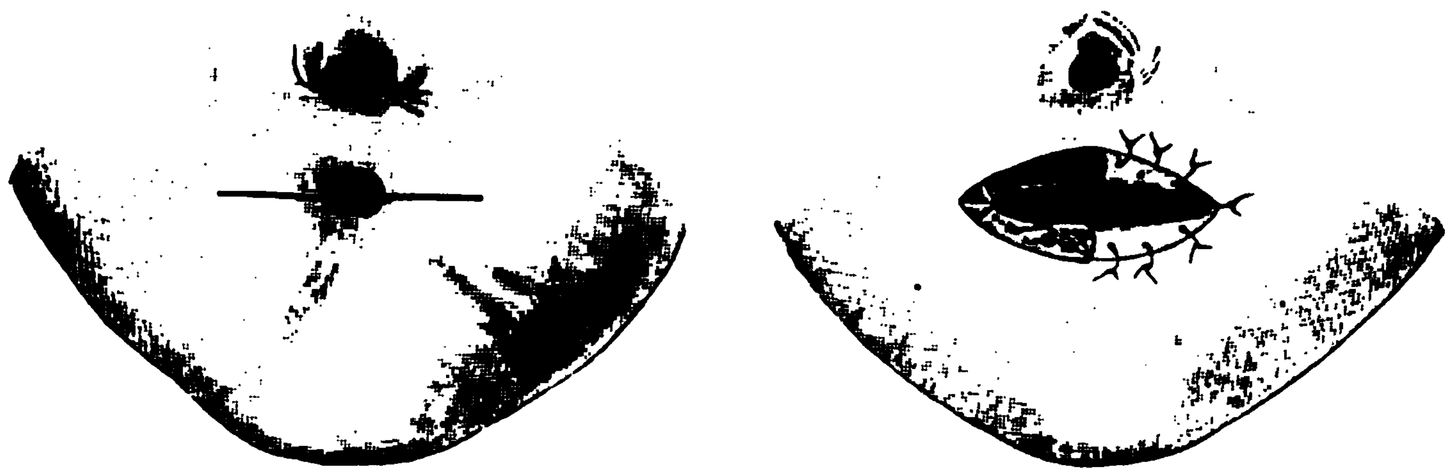
narrowing follows on an operation for removal of the lower lip, in which the surgeon has been compelled to trench upon the upper, or on cicatricial healing of ulceration due to burns, lupus, noma, &c.

In cases where the margin of the lip is diseased in its whole extent, and where, after removal of the disease, the mouth may become too small, a part of the red margin of the upper lip may be utilised in the restoration of the orifice of the mouth (Figs. 169 and 170). Sufficient of the vermilion border is detached from the upper lip to allow of the strip thus made loose being drawn around the orifice of the mouth and edging round the lower lip without tension.

In other cases the **Method of Dieffenbach** may be employed in these cases (Figs. 171 and 172).

This surgeon, so famous for his plastic skill, proceeded somewhat thus: Two lateral incisions are carried from the opening of the mouth through the whole thickness of the cheek, sufficiently far to ensure the new mouth being of proper size. After this the mucous membrane is sufficiently detached (a matter often of difficulty owing to the cicatricial condition of the parts) from the skin to allow of its being stitched as an edging all round the opening of the new mouth. The surgeon must aim especially at securing that the skin and mucous membrane meet exactly at the angles of the new mouth, for if primary union of the skin and mucous membrane be not secured here, re-contraction of the new opening will certainly follow. Hence it is advisable to suture the mucous membrane at the angles in the form of small three-cornered flaps.

FIG. 171. FIG. 172.



Dieffenbach's method of restoring the size of a contracted mouth. (Esmarch and Kowalzig.)

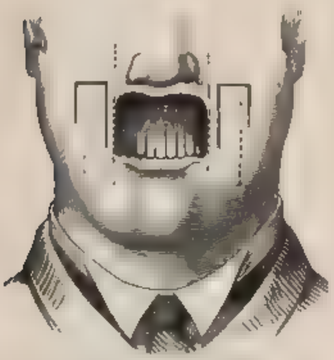
To prevent re-contraction Hüter has advised the wearing of a dilator made of ebony or hard india-rubber, of the shape of a funnel, or, more exactly, of the brim and part of a tall hat without the top.

Upper Lip.

(i.) **Operation of Sédillot by Vertical Flaps** (Fig. 173).—Flaps quadrangular in shape are raised by the following incisions: (1) the internal one, starting from a point midway between the angle of the mouth and the lower eyelid, and ending usually at a point on a level with the prominence of the chin; (2) a horizontal one passing outwards from the lower end of the first for half an inch to two inches; and (3) a second vertical incision passing upwards from the outer end of the horizontal one to a point on a level with the ala of the nose.

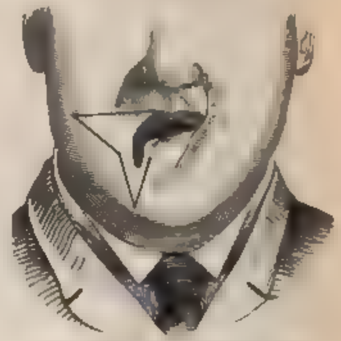
These flaps, comprising the whole thickness of the cheeks, are moved inwards so that their lower extremities meet vertically in the (ii.) **Operation of Dieffenbach and Chauvel by Vertical Flaps.**—Here the flaps are cut in the reverse direction from that of Sédillot.

FIG. 173.



The dotted lines show the operation of Sédillot, the continuous ones that of Dieffenbach, for making a new upper lip (After Serre.)

FIG. 174



Restoration of one angle of the mouth. (After Serre.)

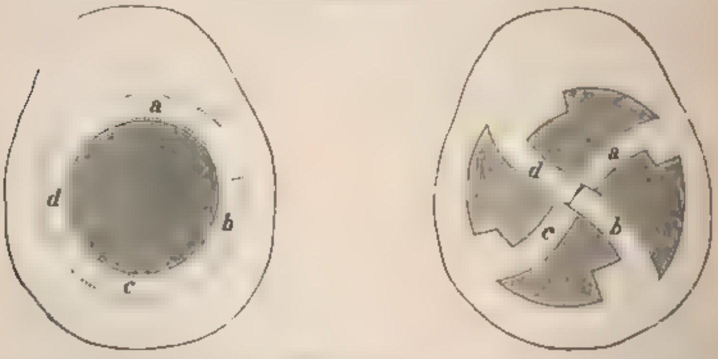
This method is to be preferred, as, owing to the base being below, there is less tendency for the new lip to be raised by the contraction of the scar, and thus to expose the upper teeth.

(iii.) **Operation by Lateral Flaps.** Here the flaps are taken laterally from the cheeks. They should be cut of the full depth of the new lip, and at their outer extremities should curve downwards so as to diminish the tension.* Their inner extremities are united in the middle line below the nose.

(iv.) **Operation for Restoring One Angle of the Mouth.**—Fig. 174 shows the steps which would be adapted for restoring the right angle of the mouth, which has been distorted by cicatricial contraction; the same proceeding being available for a growth situated here.

Defects on the Cheek and Elsewhere.—Fig. 175 shows a method

FIG. 175



(Tillmanns.)

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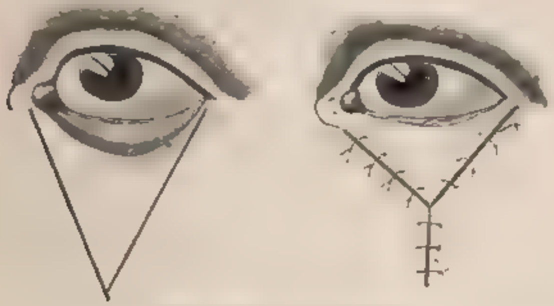
* Dr. Port, of New York, who figures this operation and numerous other methods from Szymanowski (*Handb. d. Chir. Med.*, Braunschweig, 1870), lays stress upon this precaution (*Inter. Encyc. Surg.*, vol. v. p. 489).

introduced especially for closing a gap on the scalp, which, used on a small scale, and combined with Thiersch's method of grafting, may be found useful on the face or cheek.

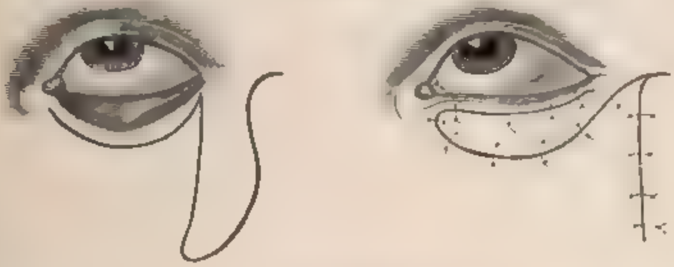
Fig. 176



(Esmarch and Kowalzig.)

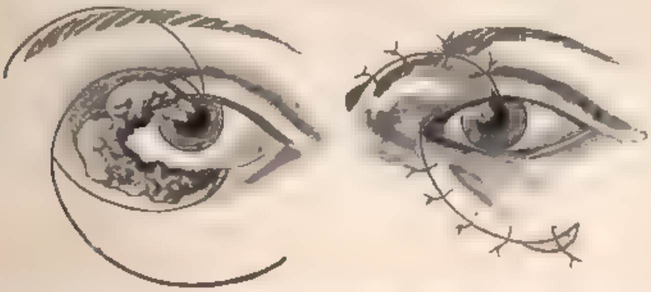
Defects of the Eyelids. Figs. 176 and 177 show different methods of curing that troublesome condition known as ectropion. Fig 178 explains how a growth around the inner canthus may be removed without deformity.

Fig. 177



(Esmarch and Kowalzig.)

Fig. 178



(Esmarch and Kowalzig.)

CHAPTER IX.

OPERATIONS ON THE PALATE.

OPERATIONS FOR CLEFT PALATE—REMOVAL OF GROWTHS OF THE PALATE.

OPERATIONS FOR CLEFT PALATE (Figs. 179 to 197).

Age for Operation.—The tendency here is to operate at earlier dates than heretofore, on account of the gain of better power in taking food and the earlier improvement in the voice. Before deciding on this point, each operator must take into consideration the general health, the vitality and nutrition of the patient, together with the width and length of the cleft, the arch of the palate, and, lastly, his own operative skill in this particular field of surgery. The surgeon will do well to remember that it does not in the least follow that because operators of special experience have operated successfully at eight, nine, or twelve months, it will be wise for him—a man, perhaps, of much smaller operative experience—to do so also. And the same advice applies to the amount attempted at one operation. Because nearly all * authorities on this matter advise closure of the whole cleft at a sitting, it does not follow that this is a wise course for those to pursue whose opportunities have been much fewer. With regard to the argument that cleft palates require operating upon in infancy, because of the difficulty of nourishing the patients,† I would reply that this difficulty can generally be met by persevering care, and, where this is not the case, the little patient is not likely to be in a state fit to meet what is one of the severest operations in infancy.

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* Mr. G. A. Wright, of Manchester and the Pendlebury Hospital, is an exception. In quite young children with complete clefts he considers it an advantage to close the soft palate alone first, and the hard a few months afterwards (*Diseases of Children*, third ed., p. 165).

† Cases are very rare in which sufficient food cannot be given by one of the following methods (especially after any co-existing hare-lip has been closed), if only sufficient pains are persevered with—viz., a small spoon passed well back into the mouth; a feeding-bottle with a teat big enough to fill the gap, the teat being perforated underneath for the escape of the milk, only a little being given at a time; an ordinary feeding-bottle, with a leaf-like piece of india-rubber attached above the teat, so as to fill up the gap (as advised by Mr. Coles); finally, sometimes deglutition will be facilitated if the nurse closes the nostrils with her finger and thumb every time the child swallows, or feeds the child well propped up. It is often advisable to take these cases into a hospital, and put them under the care of a specially trained nurse. The nutrition is usually at once improved, and the mother can be taught to maintain the improvement until the child is about two years old (p. 429).

With regard to the voice, while there is no doubt that the earlier a successful operation is performed the better will be the voice, it is possible that this has been too strongly put forward, to the exclusion of the other side of the question. Thus, the possibility of an unsuccessful operation, with the inevitable loss of tissue, and scarring of what remains, has been too much kept in the background. And children under two years of age cannot have contracted a habit of speech so bad as, of itself, to call for operation before this date.

The late Mr. Davies-Colley (*Trans. Med. Soc.*, vol. xix., 1896. p. 70) stated that when he had the opportunity of choosing the age he preferred fourteen months. Mr. E. Owen (*ibidem*, p. 68) gave his opinion that "For a soft palate, the child being in good health, the time for operating is somewhere in the first six months, I think. For a hard and soft palate together, it is, I think, in the second year." Mr. Clutton (*St. Thomas's Hosp. Rep.*, 1896, vol. xxv. p. 121) writes: "I believe that a very large proportion of the worst cases of cleft palate can be safely operated upon before the second year is completed." Mr. W. A. Lane (*Clinical Lectures*, p. 15) writes: "I find the best age for operative interference is during the fifth week, providing there is no special indication to the contrary, by which I mean bronchitis, diarrhœa, and the results of bad feeding generally."

Writing as I do for the guidance of many of my younger brethren, I consider that the end of the first year should be reached before a cleft of the soft palate should be operated upon, and then only under favourable conditions, and that the patient should be two years old, at least, before a complete cleft is operated upon. As experience is gained, operations may, no doubt, be performed successfully at an earlier date, but at any time during the first year of life the risks of failure are great, owing to the effects of hæmorrhage, the readiness with which convulsions are excited, the liability to bronchitis and diarrhœa, and, lastly, the delicacy of the soft parts and the readiness with which they tear. I am very glad to be supported here by an old friend, G. A. Wright, Surgeon to the Children's Hospital at Pendlebury, Manchester, and also Surgeon to the Manchester Infirmary. Writing in 1899 (Ashby and Wright's *Diseases of Children*, p. 171), this authority states: "For choice the operation should be performed between the fourth and sixth years, but in the less severe cases it may be done as early as the third year; before this it is not wise to attempt it, unless in exceptional circumstances, since the risk both of failure of the operation and of the child's life is much greater, though some surgeons advocate operation in the second or even the first year. We have operated also earlier than the time we have advocated, in slight cases, but are not inclined to attempt closure of a severe case of cleft of both hard and soft palates earlier than the third year at soonest."

Order of Operation on Lip and Palate.—Another question that has been raised with regard to operations on cases of cleft palate in infants is whether the cleft palate or the hare-lip, which usually complicates the cases, should be taken in hand first. Mr. W. A. Lane has strongly advocated (*loc. supra cit.*) leaving the hare-lip until the cleft palate is closed, as the gap in the lip facilitates closing the cleft in the palate. This is, no doubt, a very important point, but there are two others to be considered. One refers to the wishes and feelings of the parents, especially the mother, who, as long as the hare-lip is unclosed, has the consciousness that her child is different from others, the hare-lip being constantly before her eyes, while the cleft palate is less obvious to others as well as to herself. Another point is that, supposing Mr. Lane's plan to be followed, if the operation on the cleft palate fail, that on the hare-lip will have to be deferred owing to the condition of the child, and the feeding will be imperfect as long as the lip is open, especially in the children of the poor. On the other hand, if, as I advise, the hare-lip, for the sake of the child's nutrition and the feelings of the mother, has been closed when the infant was about three months old, and if, when the cleft palate is taken in hand at about the age of two years, it is found that the lip is very tight and interferes with the satisfactory use of a gag, there should be no doubt whatever as to slitting the lip before an attempt is made to close the palate.

Severity of the Case and Kind of Patient.—It is not so much the extent of the fissure—whether the soft palate is alone affected, partially or completely, whether that common form in which the cleft involves the soft and a portion of the hard is present, or whether the whole part is split—that is of importance, as the width of the cleft and the thickness of the tissues which bound it. Sir W. Fergusson was, I believe, the first who pointed out the influence which the height of the vault of the hard palate has upon an operation for closing a cleft of it. He showed that the higher the vault the more easy is it to dissect down flaps of muco-periosteum; while, on the other hand, the less arched the vault, the greater is the difficulty in getting sufficient flap. Other points of importance are the size of the mouth, a very narrow or small one interfering with the use of the needful instruments; and, finally (a point always to be noted), the length of the palate, for the shorter this is, the more impossible will it be for this to touch the pharynx later on, however perfectly it has been united, and the more marked, consequently, will be the nasal tone of the voice.

Other points of importance, but not connected especially with the cleft, are some which bear upon the general health of the patient—viz., fretfulness, or a sunny temper; greediness, as likely to cause bolting of surreptitious food; coexisting ear disease, or congenital syphilis; whether the child has had the usual illnesses and exanthemata—an attack of whooping-cough, scarlet fever, mumps, or measles interfering much with the result of an operation.

Amount to be closed at One Sitting, and Order of Operation on the Palate.—Where the cleft involves both palates, that through the soft is usually taken first, the severer operation being left till later. As to the amount which should be attempted at the first sitting, each case must be decided by itself, according to the experience of the operator, the severity of the case, and the safety with which the anæsthetic is taken. Sir T. Smith, the highest authority we have on this subject, recommends* that the whole cleft should be closed at one sitting, "unless there are circumstances of peculiar difficulty in the case. When the bringing together of the whole cleft in one operation would necessitate so free a division of the soft parts as to endanger the vitality of the flaps, it is advisable to close first that part of the cleft that can be most easily approximated, whether it be the hard or the soft palate."

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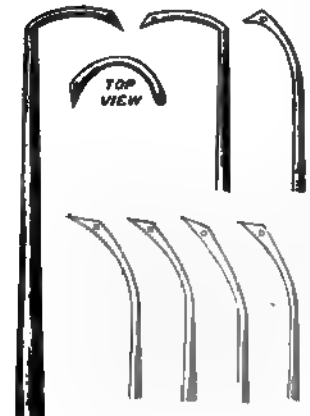
* *Dict. of Surg.*, art. "Cleft Palate."

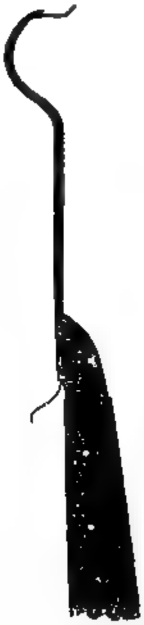
Fig. 179.



Durham's needles of different patterns.

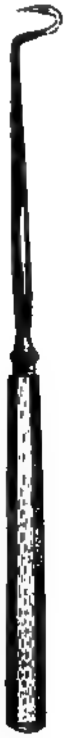
Had it not been for this opinion of Sir T. Smith's, I should have unhesitatingly advised the surgeon, in his earlier operations, only to attempt to close those parts which come readily together (*vide supra*, p. 428). Any more than can thus be closed will only be so at the expense of a good deal of tension, and after much difficulty and a varying degree of bruising, &c. Any adenoids or enlarged tonsils should be removed months before, and the presence of carious teeth must be attended to as possible sources of sepsis.

Fig. 180.



Cleft palate needle, tubular.

Fig. 181.



Cleft palate needle. Durham's double curve.

Operations on the Soft Palate.—The instruments which would be required for closing a complete cleft of the palate may be enumerated here once for all. One double-edged and one blunt-pointed knife (like a large tenotomy-knife on a long handle), one pair of dissecting-forceps, and one with fine tenaculum or mouse-tooth ends, several needles of different patterns with eyes at the point, or a supply of small needles of different curves, to be used with a holder, a stout aneurysm-needle, four raspatories of varying curve and strength,* a pair of curved scissors (with a ¼-inch curve) for detaching the soft palate from the hard, one of Sir T. Smith's gags,† which has previously been found to fit the patient, and sponge-holders. In addition to the above, a tubular needle with a reel for passing wire and a wire-twister, will be found useful.

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* If the cleft encroach at all upon the back of the hard palate, some raising of the muco-periosteum and separation of the soft parts at the junction of the hard and soft palates (p. 435) will be needed to avoid tension of the flaps.

† Those usually sold are much too large and clumsy.

The patient's stomach being just empty, so that he shall not vomit during the operation, nor want food immediately after, he is placed on a suitable narrow table, and in a good light. As soon as he is well under the anæsthetic (A. C. E. or chloroform), his hands and arms are secured in a jack-towel, one being always left within reach of the anæsthetist. Then either the head and shoulders are suitably propped up with firm pillows, or, as I much prefer, the head is dropped at a right angle to the spine, over the end of the table, where it is supported by a sitting assistant. This method, which we owe to Rose, of Berlin, has the great advantages of giving thorough exposure of the parts now well under the surgeon's control, and of allowing the blood to collect in the upper naso-pharynx. The congestion of the parts which sometimes follows is usually temporary. Sir T. Smith's gag is next introduced, the tongue tucked under the central plate, and the jaws widely opened. The gag, which it is well not to tie, is then held by an assistant, who at the same time supports the head and moves it to suit the operator. Another assistant hands instruments and gives other help, while sponges are wrung out and supplied on holders by a nurse.

The edges of the cleft are first pared in one of two ways—viz., by holding in the tenaculum-forceps the tip of one-half of the uvula, thus making the soft palate tense, and then transfixing the centre of each cleft alternately with a double-edged tenotome, cutting first up and then down. In either case the whole of each side should be made raw, and with as wide a surface as possible; it is the anterior angle and the tip of the uvula which are liable to remain unrefreshed. As far as possible this should be the only occasion on which the flaps are touched with the forceps.

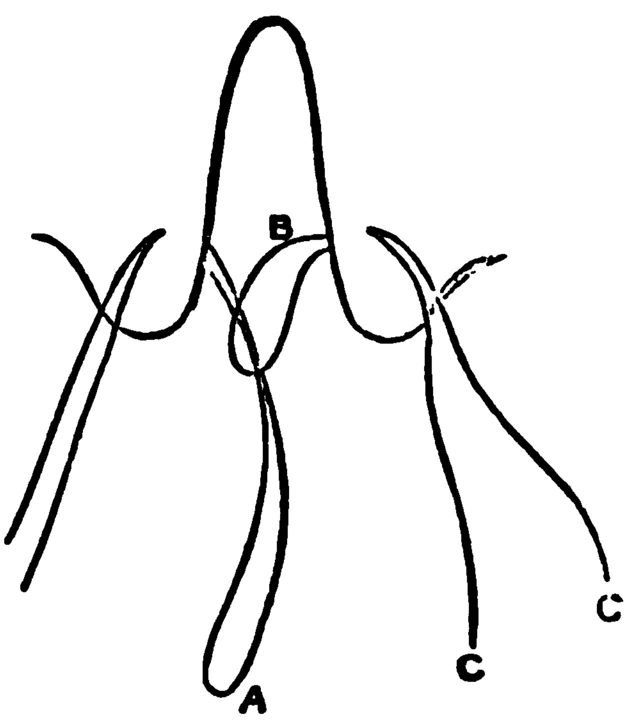
The sutures may be made of wire (without kinks), salmon-gut, horsehair, and very rarely (*vide infra*) carbolised silk. Of these Sir T. Smith prefers wire for the hard palate and for any part of the soft in front of the uvula, preferring horsehair for the uvula itself.

Each surgeon will, in difficult cases, find advantage from being used to certain sutures. If the operator have tubular needles, and if both sides of the cleft can be spanned at once, he will find it very easy to work with silver wire. Salmon-gut and horsehair seem to me to be the least irritating next to wire, and very easy to work with after being softened by boiling. But if the cleft be a wide one, and if Avelings method be preferred, it is difficult to obtain the last two forms of suture in sufficient length, and sterilised silk should be made use of. This, however, is the only condition under which silk is to be used, and even then, the surgeon should not rely on silk entirely. However carefully sterilised it may be at first, it is always liable to cause suppuration and ulceration along the tracks of the sutures, and to necessitate their removal before the line of union is sound. Wire, salmon-gut, and horsehair may, if not tied too tightly, be left for an indefinite time.

The following methods will be found useful, according to the width of the cleft, and the needles used: (1) If a tubular needle be at hand, silver wire can be passed with great facility, if the cleft be a narrow one, save in the case of the uvula, for which horsehair should be used.

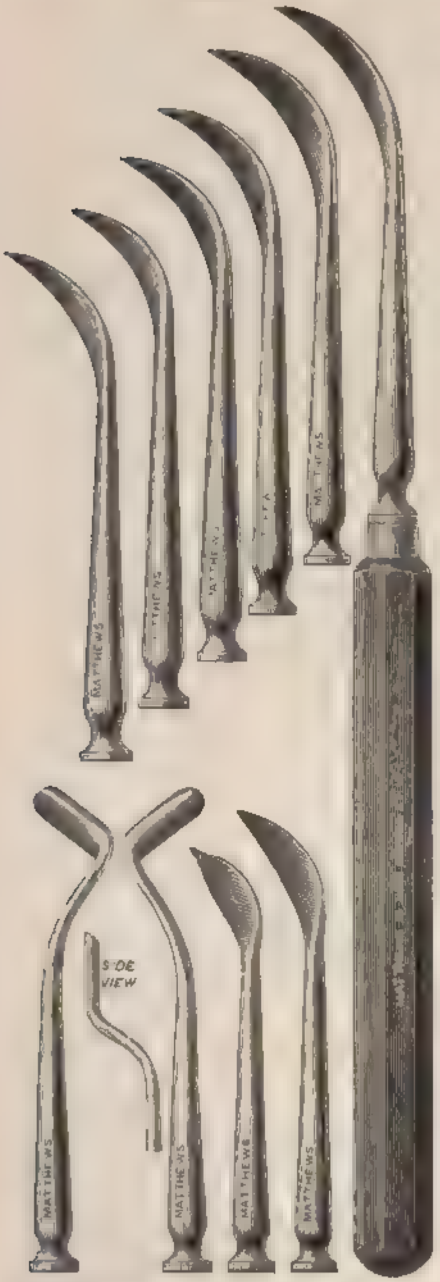
If the cleft be a wide one, the sutures may be passed in one of the following ways: (2) A slightly curved needle in a handle is passed through the edge on one side into the cleft; it is then threaded with wire and withdrawn, the wire is disengaged, the needle passed similarly through the other side, and threaded with the end already passed; this is then drawn through the second side by removing the needle, the wire being thus brought across the gap. I owe my knowledge of this, Mr. Hardie's very simple method, to an old friend, G. A. Wright. (3) Fishing-gut or horsehair is introduced by pushing a loop through one side by an almost straight nævus-needle, and withdrawing it through the opposite side by a similar needle which has a suitable slot in it, instead of an eye (Clutton). (4) Aveling's: A double loop of suture (this is much more easily done with silk) is passed on one side, and the loop drawn out of the mouth and held by an assistant; a single suture is then passed through the other side at a point opposite to this, and the end also drawn out of the mouth: this single suture is then looped into the double one, and by pulling this latter back the single one is drawn across the cleft. (5) Fergusson's method: Here it is intended that the silk threads passed should be carriers of silver wire, which is to constitute the permanent sutures. The obvious objection to this method is that so much material traverses the delicate flaps. One of the needles shown in Fig. 179, threaded with medium-sized sterilised silk about sixteen inches long, is passed through the oral aspect of the flap, sufficiently far from its margin to give good holding, and to allow for paring, if this has not been done already. The loop of silk (A) is next seized by forceps, introduced within the cleft, the needle withdrawn, and the loop pulled forward sufficiently to be laid on gauze on the face, where the anæsthetist or an assistant takes charge of it. The same thing is then done at an exactly corresponding point on the opposite side. By loosely threading the one to his left through the one to his right (B, C, C), and gently pulling on the latter, the surgeon safely carries the former through the flap that lies to his right side (Fig. 182). He then takes a piece of silver wire of suitable size, about six inches long, and doubling half an inch of this into a hook over the loop, by gently pulling on the free ends of the loop he draws the wire into its place across the cleft. (6) Here the sutures are passed much as in uniting an ovariotomy wound. A small curved needle is threaded at each end of a suture, and one is first passed in a needle-holder from right to left, and the other from left to right. An assistant holds one needle while the surgeon is using the other. The second and third methods are the easiest of all, and as efficient as any. I advise my readers to practise these two. In using the second, in which the needle is passed unthreaded, it is a great help, as one of the surgeon's hands is engaged holding the needle *in situ*, and the other perhaps in sponging, if an assistant or nurse kneel on a pillow

FIG. 182.



Loop-method of passing sutures. (Mason.)

FIG. 183.



Mr Durham's raspatories for detaching the flaps in cleft palate operations. Those in the left hand lower corner are used in closing the anterior part of the cleft. Any one buying these instruments should have them made on a smaller scale.

at his right side, and, having both hands disengaged, thread the needle.

After the first suture is passed through the halves of the uvula, it should be used to make the edges tense, thus doing away with any need for the forceps. Attention should be paid to inserting the sutures at a sufficient distance from the edge and a due distance from each other so as to equally distribute amongst themselves any tension that may be present. In passing a suture, the needle point should be quickly stabbed through at the intended spot. When sufficient sutures have been passed, two or three should be tied (the wire being twisted with the fingers, with a twister or torsion-forceps),'the gut and horsehair requiring a third knot. Then, if there is too much tension on the rest, longitudinal incisions may be made on each side of, and parallel to, the cleft. The length of these relieving incisions must vary; they usually begin on a level with the highest stitch in the soft palate, and run backwards about midway between the teeth and the cleft, care being taken not to prolong them dangerously near the posterior pterygo-palatine canal (p. 445). Where there is great tension, as in very wide clefts, these incisions must be carried boldly backwards through the soft palate, anterior pillar, and even through the substance and free margin of the tonsil. Both pillars of the fauces should, in these cases, be divided with scissors low down. This not only relieves tension but allows the palate to be drawn up to a higher level. "This is an immense advantage for the improvement of the voice" (Clutton). The bleeding from the incisions of relief will be severe, but yields to pressure applied firmly, and all tension is thus relieved. Throughout the operation the bleeding must be arrested by the surgeon himself, or by careful assistants making pressure firmly on the right spot with small aseptic sponges in holders. Pressure duly and carefully applied may be relied upon to arrest the bleeding without damaging the flaps. There must be no unnecessary manipulation of these, and, above all, no bruising of them. Dabbing sponges about needlessly does no good as regards the hæmorrhage, while it is harmful in exciting exudation of mucus and injuring the soft parts. Any clots that may form should be deftly caught in a sponge with a turn of the wrist, and quickly removed. The more the surgeon himself does the sponging the better. He knows best how to do it; he sees best where it is required, and his looking to it himself will save additional hands in an already confined space. Sponges on holders should be handed to him, singly, by an assistant who is kept supplied with them by a nurse. If the blood, in spite of the above precautions, collect in the pharynx and nose, the child should be turned right over, the head held by the hair, and the blood allowed to run out into a basin on the floor. If much blood get into the stomach, it is a certain emetic.

The after-treatment and the causes of failure are given a little later at pp. 443, 445.

Operation on the Hard Palate.—An incision is made on each side down to the bone with a small stout scalpel, from a point a little anterior to the apex of the cleft, immediately behind the lateral incisor, parallel with the alveolar margin, back to one opposite to and just internal to the last molar tooth, and reaching from the anterior edge of the cleft to the posterior edge of the hard palate. Through this incision raspatories (Fig. 183) of suitable length and curve are introduced next to the bone and pushed inwards till their points appear in the cleft. By movements from without inwards the mucous membrane and periosteum are separated from the bone, every possible care being taken to raise these of even thickness and without laceration or button-holing. The chief difficulty will be met with at the two ends of the bony clefts. If the anterior extremity of the gap reaches as far as a point just behind the incisors, much difficulty will be met with in separating the muco-periosteum here, and the surgeon will do well to be provided with two or three small raspatories of different curves. The double-curved ones (Fig. 183), bearing Mr. Durham's name, and of old so skilfully used by his deft fingers, are very useful. Again, at the junction of the hard and soft palates, the soft parts are firmly bound down to the former by fibrous tissue. To free them the raspatory should be pushed into the cleft at the junction of the oral and nasal mucous membrane, and carefully but thoroughly moved from side to side so as to free the palate here completely. A pair of angular scissors may also be used, one blade being placed under the muco-periosteum, between it and the bone, and the other passed through the cleft, above the soft palate, the fibrous tissue being thus divided close to the bony palate. A third spot where difficulty may be experienced, and much attention needed, is the attachment of the soft parts in the neighbourhood of the hamular process. Here a curved raspatory, a blunt-pointed narrow curved bistoury, or curved scissors—each being kept close to the bone—must be thoroughly used. As Mr. Rose advises, the introduction of the left forefinger into the incision is of great assistance in effecting the separation here and at the back of the hard palate with precision and thoroughness. The thorough separation of the soft parts, especially at the junction of the hard and soft palate, by relieving all tension on the sutures, and by doing away, probably, with the need of prolonging backwards the lateral incisions, is the key of the operation.

With regard to the date at which the flaps are pared, many surgeons do this at the beginning of the operation, as it facilitates the free use of the raspatory in raising the muco-periosteum from without inwards. Mr. Rose, on the other hand, advises that the paring be postponed until the flaps have been detached, as the raw edges are thus less liable to be bruised by the sponges, and with the flaps loosened the margins can be pared with greater accuracy. I recommend that his advice be followed.

While the soft parts are thus separated the hæmorrhage will be free, but always yields to sponge-pressure applied as advised above.

FIG. 184.

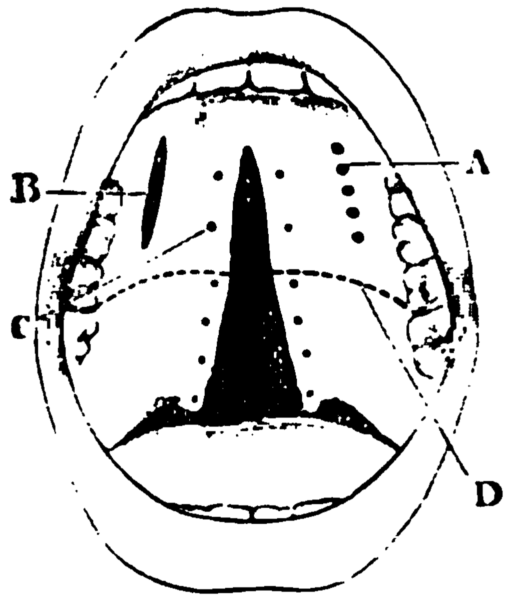
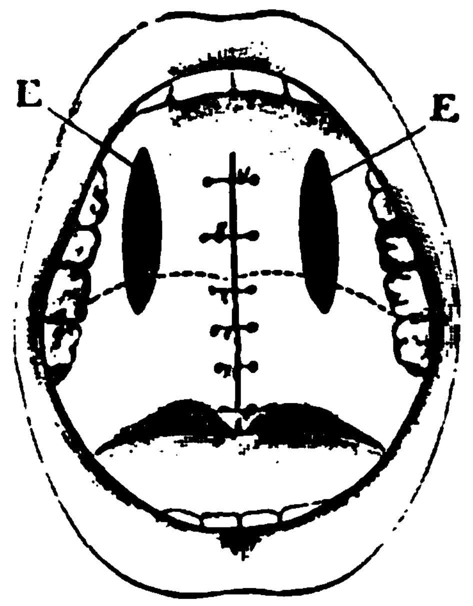


FIG. 185.



A, Preliminary punctures with the bradawl to give line for the chisel.
B, Incisions through the bone completed by the chisel.
C, Holes in the palate for the sutures.
D, Junction of the hard and soft palate.
E, Lateral openings subsequently filled up by granulations. (Bryant.)

When all bleeding has stopped, the sutures are inserted as before (p. 432), wire or salmon-gut being used here.

Tension may in part be removed by prolonging the lateral incisions backwards, when this step is really needful.

Sir T. Smith points out that, in bringing together the halves of the palate, care must be taken to evert the edges of the cleft with a small double hook in passing and twisting up the sutures.

Sir W. Fergusson's Method* (Figs. 184 and 185).—This surgeon, finding that even in his hands attempts to completely close the hard palate often failed owing to the contraction of granulations, by which the lateral flaps were drawn back to their original position, introduced the following modification, which he especially recommended for apertures in the hard palate, but which he had used with great success in a complete cleft of both.

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* *Brit. Med. Journ.*, April 4, 1874. Sir W. Mac Cormac in the same journal (May 20) points out that Dieffenbach and Wutzer had first used a very similar operation.

Sir W. Fergusson, having pared the edges, divided the palate, both soft tissues and bone, first with a scalpel and then with a chisel,* about a quarter of an inch from the margin of the gap on each side. With the chisel pushed up into the nose through each incision, by slight movements from side to side, each lateral portion was prised towards the other until they met in the middle line, when sutures were inserted between the pared edges of the soft parts. In some cases sutures were inserted not merely into these edges, but were passed through the lateral apertures right across the gap.† Hæmorrhage was arrested by plugging the lateral incisions, if needful. Nowadays aseptic gauze is best used for this purpose. Sir W. Fergusson stated his belief that the objections which at first arise to his method are not valid—(1) There is no caries or necrosis; (2) there is no dangerous hæmorrhage; (3) there is less risk of sloughing than by the old method; (4) the lateral incisions heal well. He admitted that if, as sometimes occurs, the vomer was found attached by its lower margin to the palate, it would be difficult to introduce stitches. But approximation alone of the edges would probably convert the gap into a mere chink, imperceptible to ordinary observation. Other surgeons have, however, found that this operation is certainly attended with the above disadvantages, and that the hæmorrhage and sloughing may be followed by septicæmia in weakly children, and in a region like this which cannot be kept aseptic. It is noteworthy that Mr. Rose, who was one of Sir William's assistants, does not recommend the operation. I consider it a much severer operation than that usually performed, and only to be resorted to in the case of very wide clefts, or where a previous operation has failed.

Mr. Davies-Colley's Flap Method for Hard Palate (Figs. 186 to 188). This was first published by its inventor in the *Brit. Med. Journ.*, Oct. 25th, 1890, and recommended as applicable (1) in infants; (2) in cases where the ordinary operation had failed; and (3) in cases in which the cleft of the hard palate was too wide to be bridged over by the ordinary operation. The late Mr. Davies-Colley afterwards published his method in a modified and extended form (*Trans. Med.-Chir. Soc.*, 1894, vol. lxxvii. p. 236). It may be divided into the three following stages:—

"*First Stage: that of Incision and Separation of the Muco-periosteum* (Fig. 186).—The patient being under an anæsthetic, and the jaws held open by a Smith's gag—(*a*) an incision, *a b*, is made from before backwards, about an inch long, with its centre just internal to the last molar tooth. It should go down to the bone in front, and behind it should pierce the soft palate. Through this incision a raspatory is introduced, and the soft parts separated inwards from the posterior half of the hard palate, much as in the ordinary operation, but not to such an extent.

"(β) An incision, *c d*, is carried on the same side from just in front of the cleft, and at a distance of about a quarter of an inch from its margin, backwards to the junction of the hard and soft palate. As it approaches the soft palate the incision should converge to the edge of the cleft, and it should be continued along the edge of the soft palate in such a way as to split that structure to the depth of about three-eighths of an inch. For this purpose the knife should be lateralised, and as the knife approaches the uvula a forceps will be required to hold the uvula steady while it is being divided. At this part the incision must be not quite so deep, in order to avoid the complete division of the lateral half of the uvula. The soft palate near the cleft will now consist of two planes—a lower one which is continuous with the band of muco-periosteum between the two incisions, *a b* and *c d*, and an upper one attached to the back of the hard palate. The muco-periosteum internal to the incision *c d* should be separated *inwards* from the bone until it is left attached by the soft tissue which covers the margin of the cleft of the hard palate.

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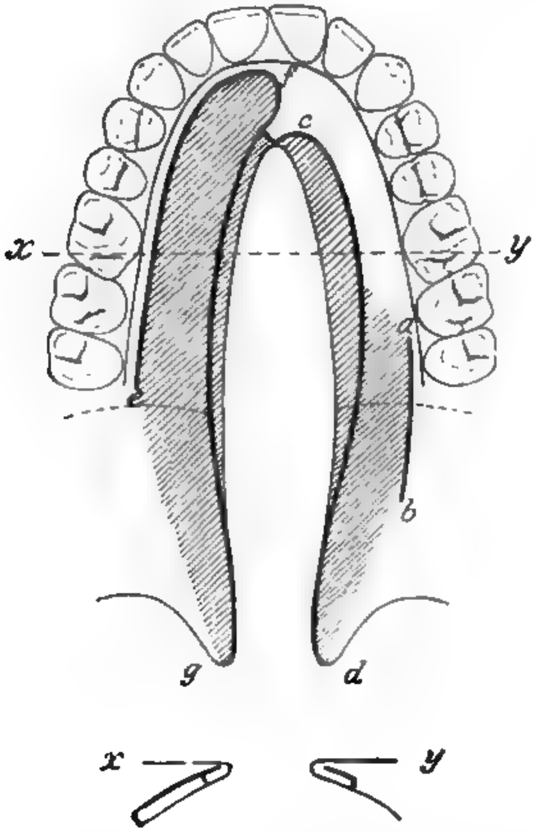
* Preceded in some cases by drilling a line with a bradawl, as in Fig. 184, drawn by Mr. Rose for Mr. Bryant's *Surgery*, vol. i. Figs. 184, 185.

† Sir W. Mac Cormac (*loc. supra cit.*) shows that Dieffenbach made use of similar sutures, sometimes securing further approximation by again twisting them up later on.

Fig. 186.

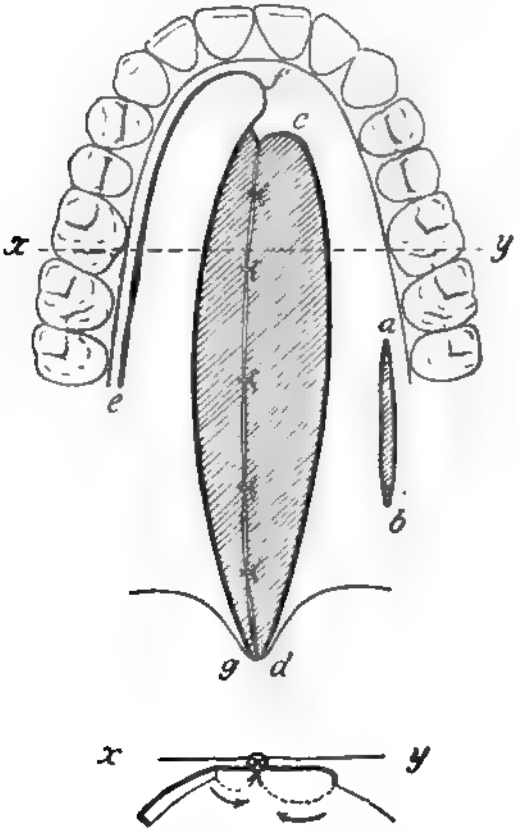


The shading indicates, in the hard palate, stripped-up periosteum; in the soft palate, the stripping into two planes. The lower figure represents diagramatically a transverse vertical section through the hard palate along the line *x y*.

"(γ) A large flap, *e f g*, of somewhat triangular shape, but with the front angle rounded, should be taken from the other side of the palate. One side of the flap, *e f*, runs parallel to and a sixth of an inch from the insertions of the teeth from the last molar to the median incisor;

the other, *f g*, runs backwards at a distance of a sixth of an inch from the margin of the cleft of the hard palate, and continuous with a splitting of the soft palate similar to that upon the other side, and reaching as far back as the tip of the uvula. The muco-periosteum of the triangular flap should also be separated from the hard palate by means of the raspatory, and, finally, that which lies internal to *f g* should be separated inwards, until it is only attached to the margin of the cleft.

Fig. 187

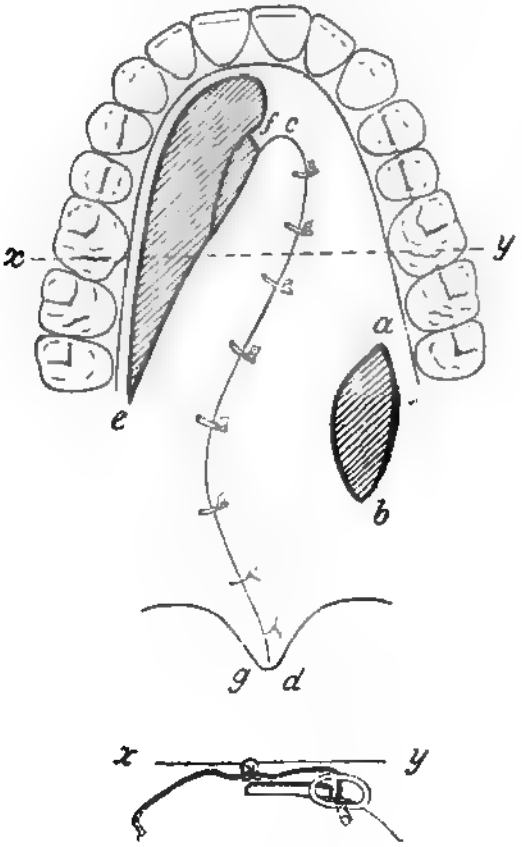


The lower part of the diagram represents a similar section to that shown in the preceding figure. The arrows indicate the direction in which the muco-periosteum of the margins of the cleft is reflected inwards.

"*Second Stage: the Union of the Mesial Flaps and the Upper Planes of the Soft Palate* (Fig. 186).—By means of an ordinary palate-needle, with the curve at the end in a plane at right angles to the stem, five sutures of silk or catgut are passed through the edges of the flaps internal to *c d* and *f g*, care being taken to turn the flaps inwards so that their mucous covering looks upwards and their raw surface downwards. Continuously with this union the edges of the upper plane of the soft palate on either side must be brought together in the same way. From four to six sutures are necessary for this stage. When it is completed the whole cleft of the hard and soft palate should be bridged over by a layer of muco-periosteum and soft palate tissue, with the raw surface looking downwards.

"*Third Stage: Union of the Triangular Flap and the Lower Planes of the Soft Palate* (Figs. 187. 188).—With the same needle, sutures of soft silver wire are now passed in the ordinary way so as to draw over the margin,

FIG. 188.



The lower part of the diagram represents the same section as that shown in the two preceding figures.

f g, of the triangular flap to the outer edge of the incision *c d*, on the other side. At the same time the margins of the lower planes of the split soft palate are brought together in the same way. About six wire sutures are necessary, and two silk or horsehair sutures may be used for the approximation of the uvula and the adjacent parts of the soft palate. There will now be a second complete bridge across the cleft, but in this bridge the mucous surface will look downwards, while the raw surface will look upwards and be in contact with the raw surface of the first bridge. The incision *a b* gapes widely, and may have to be increased in size, especially at the expense of the muscular tissue of the soft palate, in order to allow the edges to come together without tension.

"The *after-treatment* is similar to that which is usual after the ordinary operation. I have generally allowed an interval of at least three weeks, and sometimes as many as six weeks, before removing the sutures of the third stage, while those of the second stage have to be left to come away as they can, or to be absorbed.

"There is so little tension, that if primary union should fail, secondary union would probably take its place. For a short time a raw surface is left in the opening made by the gaping of the incision *a b*, and on the other side over the space previously covered by the triangular flap; but these surfaces soon get covered with granulations, and give rise to no trouble or deformity."

The chief advantages claimed for this operation are—(1) No tissue has to be pared away. (2) A much larger extent of raw surface is brought into close contact than by the ordinary operation. (3) The tension, at any rate in the lower bridge uniting the sides of the hard palate, is much less. (4) Where, as in the ordinary operation, the pressure of the tongue tends to tear apart the slender line of raw surface which has to unite, in this operation the pressure is beneficial, as it keeps the raw surfaces of the two bridges in close contact.

The chief *disadvantage* is that the operation takes about half as long again as the ordinary operation, because of the number of sutures to be inserted. As to the danger of sloughing when so large a flap has been so freely detached, the late Mr. Davies-Colley had never known this to occur. Speaking at a meeting of the Medical Society (*Trans.*, 1896, p. 70),* Mr. Davies-Colley said that his more recent experience, since reading his paper eighteen months before at the Medico-Chirurgical Society, had been three cases of complete cleft between fourteen and eighteen months of age. In two he had succeeded in obtaining complete union of the hard, and considerable, though not complete, union of the soft palate. He repudiated the idea of wishing to adopt the flap operation in every case. Of six cases which he had had in the last six months, four had been done by the ordinary method, but he did not employ this method in the case of young children, because the flap operation was so much more certain in its effect.

Flap Method of Mr. W. A. Lane (*Clin. Lect.*, p. 15).—Mr. Lane considers "the best age for operative interference to be during the fifth week, providing there is no special indication to the contrary. The advantages of operating at this early period are—(*a*) the child bears the operation very well; (*b*) the child experiences but slight subsequent discomfort, and will take its food with satisfaction within an hour or two after the operation; (*c*) the amount of hæmorrhage is very slight and is easily controlled." In his operation, which Mr. Lane describes as "to a certain extent a modification of a mode of treatment by flaps introduced by Mr. Davies-Colley some years ago," he endeavours to raise a flap of muco-periosteum from one side, and to fasten it securely beneath the separated margin of the opposite side. Fig. 189 "represents a cleft running through the whole of the hard and soft palate. A flap which is attached to the margin of the cleft is turned up from the bone of the hard palate, and is dissected off the soft palate. Great care must be taken not to tear away this flap from the margin of the cleft in the hard palate. The latter part of the operation can be done best with the form of knives shown in Fig. 193. In doing this the descending palatine vessels are exposed as they emerge in a loose periosteal sheath from a single foramen. These can be cut long, and any hæmorrhage readily controlled by a ligature or by torsion. An incision is then made along the opposite free margin of the cleft in the hard palate, and the muco-periosteum is raised from the bone for about a quarter of an inch. The soft palate on the same side is pulled forward, being held in forceps, or a thread may be passed through its extremity. It is split in the same manner as indicated in Fig. 194, none of it being removed. Lately I have frequently cut a flap from the posterior aspect, increasing still further the area of the opposing raw surfaces. This is done in order to offer a large raw surface which can be brought into accurate apposition with the reflected flap. The reflected flap is

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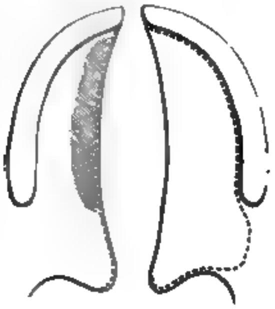
* Speaking to me in December 1899, Mr. Davies-Colley stated that he had, latterly, been increasingly adopting the old operation.

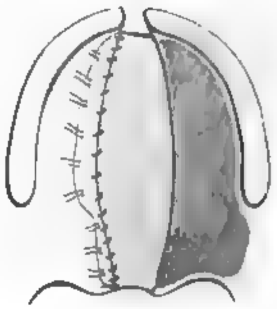
ed beneath the separated edge of the muco-periosteum

FIG. 189.



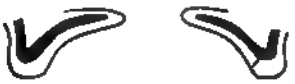
The dotted line indicates the incisions, and the shaded area the muco-periosteum elevated from the adjacent bone.

FIG. 190.



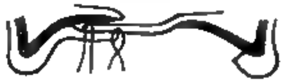
The flap is shown fixed in position by a double row of sutures.

FIG. 191.



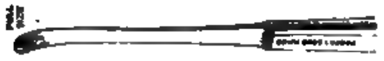
The line of incision above the margin of the flap is shown in vertical transverse section

FIG. 192.



The flap is shown raised and fixed in position.

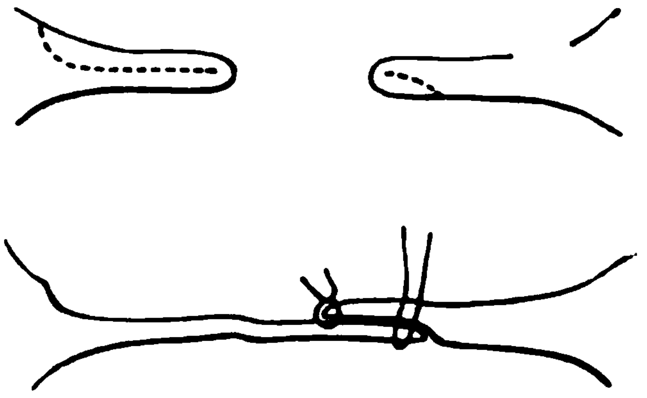
FIG. 193.



Curved knives used by Mr. Lane in splitting the soft palate. (Down Bros.' Cat.)

hard palate, and its margin pinned at intervals by sutures. Then the margin of the flap of the soft palate is similarly attached to the outer limit of the raw surface on the back of the opposite margin by means of separate sutures. The free part of the elevated border is attached securely to the raw surface of the reflected flap by means of separate or several continuous sutures. In this manner two large raw surfaces, well supplied with blood-vessels, are retained immovably in accurate apposition, and are placed under the most favourable circumstances for immediate union. It is very unusual for any portion of the flap covering in the cleft in the hard palate to give way, but occasionally the margins of the soft palate may come apart. To remedy this, after an interval of two or three weeks, a flap should be taken from the side of the hard and soft palate opposite to that utilised on the first occasion, and be retained by the same method

Fig. 194.



The way in which the soft palate is split and sutured.

Fig. 195.

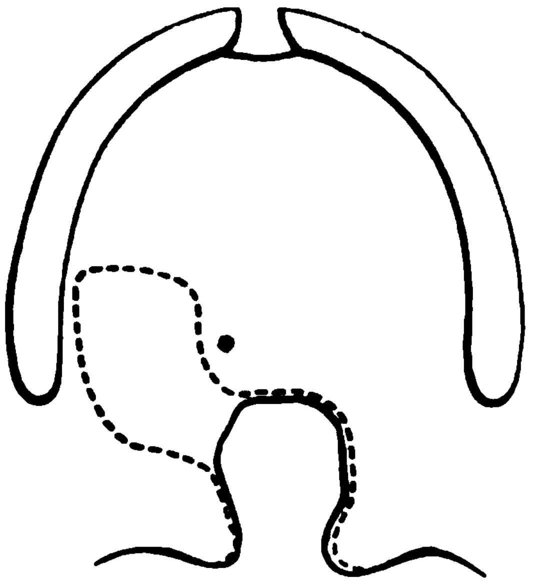
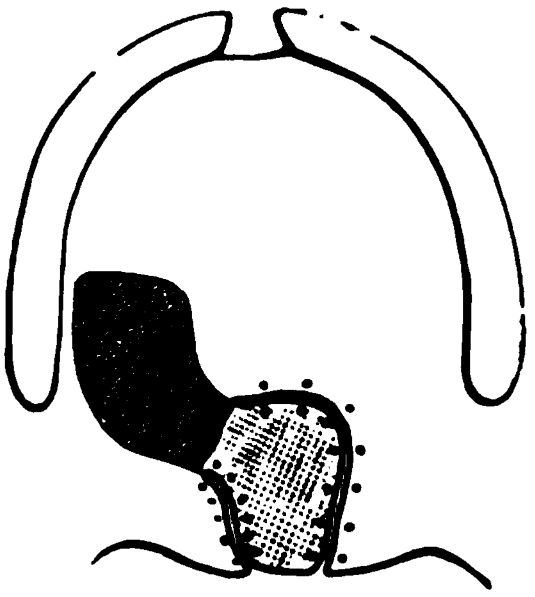
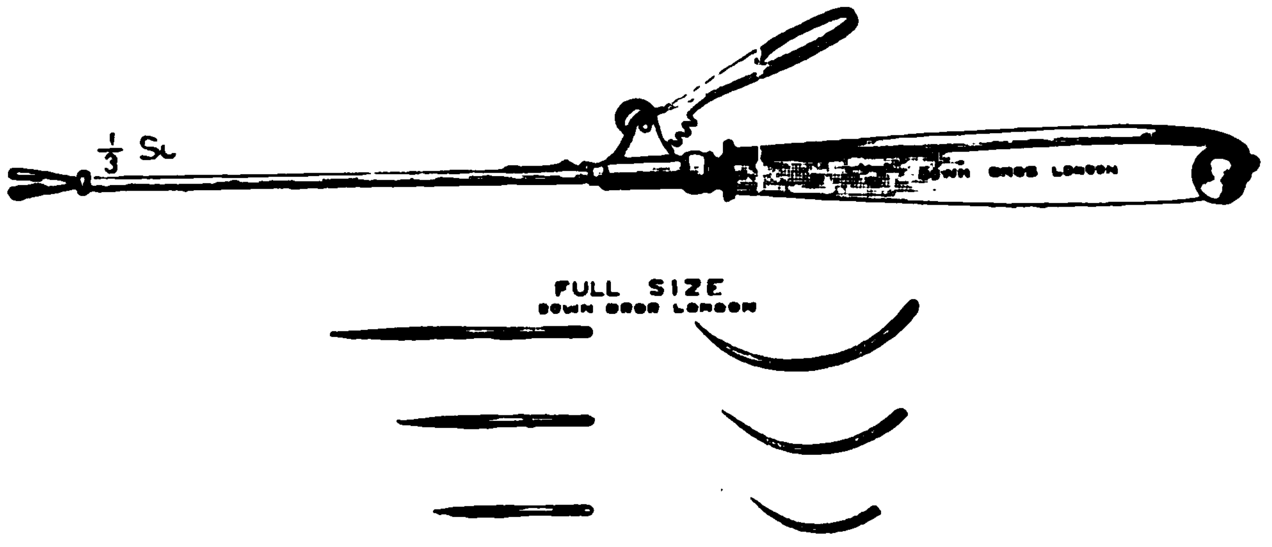


Fig. 195.



These figures show Mr. Lane's mode of treating a residual cleft in the soft palate.

Fig. 197.



Mr. Lane's needles and needle-holder. (Down Bros.' Cat.)

in the cleft. By thi- tured surfaces are exposed to a
minimum of st edles and needle-holder
d straight needles are

best suited, while the curved ones are more serviceable in the later stages of the operation. The sutures used are of the finest silk, and employed only to facilitate threading."

After-treatment.—A small injection of morphia (gr. ⅛) may be given, but no food should be allowed for three hours, only a little ice being given to suck. The hands should be secured for the first few days. For the first forty-eight hours milk with ice or barley-water only should be allowed, with a little port wine and water, nutrient enemata being given if needful. After this, yolks of eggs, arrowroot, broths, soups, and (in about ten days) light puddings, jellies, may be allowed. If the patient's temper and intelligence allow of it, the mouth may be regularly syringed or washed with Condy's fluid or boracic-acid lotion. In other cases it is best to leave the wound quite alone. The nurse should devote herself to preventing the child from crying, and to keeping the patient amused. Whenever it is possible the child should be taken into the fresh air after the first two or three days (Owen). There should be no hurry to remove the sutures, which, if not of silk (p. 432), may remain for seven or ten days in the soft, and an almost indefinite time in the hard, palate. No one should be allowed to look at them either early or often. It is well for the operator to keep out of the child's notice for the first ten days.

To make this subject of after-treatment at all complete a few words must be said about the improvement of speech after the cleft has been surgically cured, and the occasional need of an obturator. Even after a complete closure of the cleft much awkwardness of speech is liable to remain, this being, of course, most marked the older the patient is. Parents are often greatly to blame for the little trouble they will take to further the success of the surgeon's efforts, and this refers in many cases to those who have not the excuse of the ignorance and toilsome life of the poorer classes. They too often act as if, because the cleft is closed, no further responsibility rests with them. Again, the patients being usually children, without thought as to the future, and satisfied with the improvement in their deglutition, present many difficulties. Not only has the child to be taught the right way of using its organs of speech, but wrong habits, especially nasal and guttural tones, have to be unlearnt. This is only to be brought about by means of systematic lessons and practice gone through regularly day by day for months and even years. No plan will be found better than that recommended by Mr. W. Haward, Clin. Lect. "On Some Forms of Defective Speech" (*Lancet*, 1883, vol. i. p. 111): "The instructor should sit directly facing the pupil; the pupil is made to fix his attention thoroughly upon the face of the teacher, and to copy slowly his method of articulation. This should be displayed by the teacher in an exaggerated degree, every movement of the lips and tongue being made as obvious as possible to the pupil, and the more difficult sounds or movements prolonged for the purpose. Thus, for instance, suppose the word 'sister' were to be practised, the teacher, having filled his chest with a long inspiration, would open his lips and draw back the angles of the mouth, so that the pupil could see well the position of the tongue against the teeth; he could then prolong the hissing sound of the 's,' and, finally separating the teeth as the sound of the 't' in the second syllable issues, allow the pupil again to see the position of the tongue as the word is ended.

Or, for another example, take the word 'lily.' Here the teacher would separate the lips and teeth, so that the tongue would be seen curved upwards, with the tip touching the hard palate; the word would then be pronounced with a prolongation of each syllable, the teeth and lips being kept open, so that the uncurling of the tongue and its downward movement are clearly seen. So, again, in teaching the proper method of sounding such words as 'wing' or 'youth,' much aid is given by keeping the lips somewhat separated, so that the relation of the tongue and palate can be made manifest. The pupil must be made to fill his chest,* and then to imitate as closely as possible every movement and sound of the teacher; and this may sometimes be assisted by making the pupil feel with the finger as well as observe with the eye the relative movement and position of the teacher's tongue and palate. There should be no other person in the room to distract the pupil's attention. It is best to continue the exercise for a short time only, and to repeat it frequently, rather than fatigue the child by a long lesson; and it is a good plan to take an ordinary elementary spelling-book and to mark the words which the pupil finds most difficult to pronounce,† so that these may be especially practised."

With regard to the question of obturators and vela, in cases where it has been found impossible to close a very wide cleft, or where it is evident that even after a successful operation the palate will be so tense and short as to be quite unable to touch the pharynx, and so shut off the nose from the mouth, an obturator may be required. A very useful form, that of Dr. Suersen, of Berlin (*Brit. Med. Journ.*, 1882, vol. ii. p. 875), and several others, are described by Mr. Newland Pedley (*Guy's Hosp. Rep.*, 1894). The whole question is very fairly dealt with, and many useful hints are given as to the improvement of speech in these cases. The chief disadvantages of instrumental aids are that if fitted early they will require frequent alteration; on the other hand, unless worn early they will be of little service. Moreover, the expenses of the necessary repairs and renewals can rarely be met by hospital patients. Just the same care in overcoming faulty habits of speaking and in teaching correct ones is required now as after a successful operation.

Causes of Failure.—1. Vomiting.‡ 2. Premature cutting of sutures from tension. 3. Hæmorrhage. Serious hæmorrhage in children, either at the time or later, is very rarely met with, but it is otherwise in adults.

Mr. H. Marsh (*Clin. Soc. Trans.*, vol. xi. p. 71), in the case of a patient aged 21, was compelled to plug the posterior palatine canal owing to severe hæmorrhage on the sixth day.

The hæmorrhage recurred twice, the last time being as late as the fourteenth day, and was arrested on each occasion by the following means: "Searching with a sharp-pointed probe, passed through the lateral cut, about $\frac{1}{3}$ inch in front of the hamular process, which can be easily felt through the soft palate, and about the same distance directly inwards from the wisdom tooth, I felt, after two or three attempts, that I had fixed the probe in the orifice of the canal, and at the same time the patient screamed with pain when the large posterior palatine nerve was touched. A wooden plug, made by sharpening a piece of firewood, was then pressed firmly into the canal, by holding it in a pair of strong forceps with its point looking upwards, and a little backwards in relation to the roof of the mouth. Directly the plug was introduced the bleeding ceased." The recurrence was due to the plug slipping out.

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* Opening the mouth widely and learning to keep the tongue down on the floor of the mouth are two points to be early and strenuously insisted upon. The patient should practise them before a looking-glass.

† Especially those containing the letters t, b, d, k, g, s, z and l. (Rose.)

‡ Mr. Mason (*Brit. Med. Journ.*, 1872, vol. i. p. 14) gives the case of a child, aged 9, where the vomiting of two lumbrici led to failure.

4. Whooping cough. 5. Exanthemata. 6. The child putting a finger into the wound. 7. Swallowing of solid food. 8. Feeble condition of the child, with congenital syphilis, &c. 9. Acute infantile diarrhœa. Though I have placed this last, this baffling pest of surgery is too well known to those who have to operate, in the summer, on little children in hospitals. For the best account of treatment I would refer my readers to an article by Dr. G. E. Halstead (*Guy's Hosp. Rep.*, 1898). I here append a summary of his terse and most practical article:—"Diarrhœa is due to something in the diet. Empty the bowels and keep them cleansed, preferably by castor oil. Energetically treat the collapse, and don't trouble about the number of motions. Don't stop up the bowels by astringents and opium. Give hardly any food for a few days. Begin with white of egg solution in teaspoonful doses every half-hour. If the baby is too hot, cool it; if it is too cold, warm it; if it is thirsty and not sick, give it water; and keep it in the fresh air all day long."

With reference to the above causes of failure, while, very occasionally, hæmorrhage at the time of the operation in a weakly child, prolonged vomiting, or want of supervision after the operation, may be the cause, in the very great majority of cases the failure is due to some neglect of the precautions which are recognised as essential. They are (*a*) insufficient relief of tension on the sutures by inadequate use of the raspatories in freeing the muco-periosteal flaps when the lateral incisions are made, or in separating the soft parts at the junction of the hard and soft palates. (*b*) Unskilful paring of the edges, by which either not enough is done, the cleft not being completely pared, or too much is removed and the tension thereby increased. (*c*) Bruising of the edges from unskilful manipulation with instruments or sponges, difficulty in passing the sutures, &c.

REMOVAL OF GROWTHS OF THE PALATE.

Growths here, though rare, have a special interest, from their position, and may thus be briefly noticed. For a good account of them I would refer my readers to a paper by Mr. Stephen Paget (*St. Barth. Hosp. Rep.*, vol. xxii.), in which the following points are brought out: (1) The chief groups are the polypoid and warty, the adenomatous, the sarcomatous, and the carcinomatous; this last including the encephaloid, which are very rare, and the epitheliomatous, commencing in irritation here as elsewhere. (2) That it is hardly possible to tell beforehand to which group the the growth belongs. (3) Many of them, especially the adenomata, can be shelled out with surprising ease. (4) That the growth itself should not be cut into.

The commonest growths which the surgeon has to deal with here are sarcomata and epitheliomata. In either case, where the growth is large and vascular, I strongly urge the advisability of making use of such aids as a preliminary laryngotomy and plugging the fauces, slitting the cheek and ligaturing the external carotid on the side in which the growth extends farthest back. Tying the above vessel not only renders the operation much more bloodless, and so enables it to be more thoroughly done, but diminishes also the risk of secondary hæmorrhage, a risk that in a part like this, which cannot be kept aseptic, is always present. I have followed the above course in two cases, in each of which the disease implicated the pterygoid region on one side. One was an epithelioma of the hard and soft palate involving the alveolar process and the pterygoid region on the left side. This patient is alive and well, four and a half years after the operation. In the other case, one of sarcoma of the right pterygoid region and the soft palate, an operation had already been attempted by a surgeon at Johannesburg. Ligature of the right external carotid allowed of the removal of some enlarged glands at the angle of the jaw, and prevented any severe hæmorrhage when the growth was shelled out of the palate and right pterygoid region. When I saw the patient last, two years after the operation, the parts were perfectly sound.

In the case of a growth of the hard palate, peeling it off with a blunt dissector and scraping the bone will be quite insufficient. The bone around should be freely removed with a chisel or gouge and mallet, or a partial removal of the upper jaw (*e.g.*, its palate and one alveolar process) performed, if needful.

CHAPTER X.

REMOVAL OF THE TONGUE (Figs. 198 to 202).

THE day when the belief is accepted, and acted upon, that cancer of the tongue, like many other epitheliomata, has a pre-cancerous stage, and that this is the stage in which we ought to operate, will be a happy one for hundreds of patients and for the results of surgery. Of all the painful deaths by which men leave this world there are few more miserable and distressing than one which closes life by cancer of the mouth. And yet, though in the case of the tongue this most important stage is, from the position of the organ which it attacks, peculiarly under our eyes and lies open to our examination and detection, how frequently it is overlooked! I have elsewhere (*Guy's Hosp. Rep.*, 1889, p. 245) treated in detail of this malignancy and the other practical points above given.

Before describing the different operations it will be well to say something with reference to two or three very practical points which rise up with every case of tongue-cancer, a form of cancer which, it must be remembered, is very frequent, and increasing in frequency;* which attacks all ranks of life; which, after its early stage, is especially malignant;† and, finally, for the relief of which an operation is as much dreaded and deferred by men as that for carcinoma mammæ is by women.

A Pre-cancerous Stage.—However tongue-cancer begins, it passes through the above stage, *i.e.*, a stage (the duration of which is unknown, and varies extremely) in which inflammatory changes only are present, viz., ulceration and other changes in the epithelium, not amounting, as yet, to epithelioma, but on which epithelioma inevitably supervenes. The boundary line between this pre-cancerous stage and cancer is extremely narrow; the duration of this stage may be, and often is, extremely brief.

Aids in recognising this stage: (1) The duration of the ulcer. (2) Its obstinacy to treatment. (3) The age of the patient. (4) Absence of any induration or fixity.

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* Amongst common cancers—*e.g.*, of breast, rectum, uterus, &c.—cancer of the tongue stands about third, although so rare in women. Mr. Barker, in his carefully worked-out article on "Diseases of the Tongue" (*Syst. of Surg.*, vol. ii. p. 578), gives a series of tables showing that in the last thirty years there has been a steady increase from 2·6 to 11·5 per cent.

† This is shown in the following facts: (*a*) The rapidity here is quite different from that in other epitheliomata. Epithelioma, usually thought a slow cancer, here, in a moist, warm cavity, much irritated, and never dry and warty, is terribly rapid. (β) Gland n is here not only certain, but inevitably early as well.

Questions arising before Operation.

The operating surgeon will often be called upon to give an answer to the two following questions: Will the disease be permanently cured? If a permanent cure is impossible, will life be bettered and prolonged?

A. ***Will the disease be permanently cured?***

Really permanent cures are, as yet, too few, though the results of recent years are increasingly promising. Thus Mr. Butlin wrote in 1885 (*Diseases of the Tongue*, p. 295), "It may be taken for granted that a saving of ten lives in the hundred may fairly be claimed for operation in cases of lingual carcinoma." In his Hunterian Lecture (*Brit. Med. Journ.*, vol. i. 1898, p. 542) the same authority states, "The analysis of my own 102 cases, hospital and private, furnishes a percentage of 20 cured* cases. And if the 50 private cases were analysed, the percentage of cured cases is 26."

Mr. Watson Cheyne, in his Lettsomian Lectures (*Med. Soc. Trans.*, vol. xix. p. 169), gives the frequency of recurrences, both local and glandular, after operations on cancer of the tongue as varying from 61 per cent. in Kocher's statistics to 89 per cent. in Winiwarter's. I have stated above that in epithelioma here invasion of the glands is not only certain but inevitably early as well. Mr. Hutchinson (*Brit. Med. Journ.*, vol. ii. 1891, p. 1190) draws attention to the following facts, which cannot be emphasised too strongly. Gland infection here begins almost from the very day that the sore assumes suspicious features. Again, lymphatic glands may become involved through ulcers of the most insignificant size and of the briefest duration. Lastly, the same authority points out that cancer germs may remain latent in the lymphatic glands for several years and then evolve disease. Before leaving this subject I would earnestly impress upon my younger readers that invasion of the glands is here not only certain, usually early, but also now peculiarly baneful, owing to (1) the way in which epithelioma infects the glands—*inflammatory cells, as well as those of cancer, passing from the primary growth, if ulcerated, as it usually is, into the glands*; and (2) *the great importance of the structures amongst which the cervical lymphatic glands lie.* When epitheliomatous glands are operated on, the following conditions interfere with a thorough extirpation of the disease: (*a*) The number of the glands and the abundant communication between the different groups, the importance of the structures closely adjacent to the deeper ones, and the fact that the glands may be affected and yet so minute as to escape the most careful operator. (β) The presence only too often of septic cells (the original trouble being, usually, an ulcer) as well as of malignant deposit in the glands so mats them to adjacent parts as to make it quite impossible to really extirpate the glands. Inflammatory softening having set in leads to their breaking down during attempts at their removal, with the result that shells, still the seat of cancerous foci, are left behind. These relics, owing to the vascularity of the surrounding parts, do not die, but preserve sufficient vitality to act, a little later, as centres of recurrent disease.

The explanation of the small number of permanent recoveries after removal of tongue-cancer is not altogether to the credit of our profession. Patients and we, alike, are too often both to blame. The gravity of the disease is overlooked, the time of the "pre-cancerous stage" is lost. Because tongue-cancer is so often preceded by syphilis, or local irritation, the practitioner diagnoses the above, and suggests them as the essential part of the mischief: "give drugs another chance"—*e.g.*, potassium iodide, mercury, caustics.* To these there are, in nearly every case, the strongest objections in the pre-cancerous stage. Time is lost, strength is lost, and the patient is lulled and befooled, while all the time the vascularity and irritation around the ulcer are increased. Furthermore, the patient is in part responsible for the delay, as he very naturally dreads the operation, exaggerating its danger, painfulness, and the supposed inevitable loss of speech. We shall never be able to successfully combat the above till (1) the importance and value of the pre-cancerous stage are recognised; (2) getting cases of tongue-cancer early,† we are enabled to assure the patient that removal of one half of the tongue will be sufficient, and that half can be safely and usefully spared to him.

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* By the term "cured" Mr. Butlin means that the 20 patients were in sound health more than three years after the operation, 12 of them having been watched for more than five years.

B. ***If a permanent cure is impossible, will life be bettered and prolonged?***

Cases which are not operated on die within eighteen months, many in twelve months. An operation wisely planned and well carried out often gives a gain of six or eight months. This is a gain not only of time, but also of comfort. Death by glandular recurrence in the neck is less painful and noisome than death by mouth-cancer. No one who has seen much of tongue-cancer will have any difficulty in answering the question which of the two is the more painful to the patient and distressing to those around him—tongue-cancer with its horrible fœtor, profuse and foul salivation, its pitiless, incessant, weary, racking aching of tongue, ear, face, and teeth; or recurrence in the cervical glands, an alternative in which the patient is often able to work up to near the last, and, till towards the close, is free from the agonising tenderness, the stinking fœtor, the dribbling of foul saliva (not only half-poisoning the patient, but rendering him noisome to others‡), and the slow starvation day by day of tongue-cancer. Where an operation is certainly attended with risk, the patient in facing it may be relieved by the assurance that a life prolonged in hideous misery and constant agony is worse than death following close on an operation. "When a man has only, suppose, two or three years to live, it is no small advantage if at least half the time can be spent in comfort rather than in misery, and in profitable work rather than in painful idleness" (Paget). If a patient cannot make up his mind to an operation and is losing precious time, he should be warned, without being unduly frightened, of the state of things, alluded to a few lines above, which will inevitably follow. Usually, as soon as this sets in—*i.e.*, when the condition of the tongue renders him a nuisance to himself and others with the disgusting fœtor, the constant dribbling of foul saliva which cannot be swallowed, the weary aching day and night, lit up into agonising flashes when the parts are touched or moved—the patient becomes willing to run any risk. But, too often, by this time, if the glands are not already enlarged, the mischief has reached the floor of the mouth or the alveolar mucous membrane by extension, though not yet perhaps with ulceration.

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* "While a careful thorough application of nitric acid or acid mercury nitrate is perfectly justifiable in certain cases, and may be highly beneficial, the use of caustics frequently repeated at short intervals is here futile and perilous. For medical men to waste time with this treatment should at the present day be almost criminal, for such dallying with drugs and local applications can only lead to cultivation of cancer, and most miserable and often untimely deaths" (article, *loc. supra cit.*; *Guy's Hosp. Rep.*, 1889).

† If a sore has been persistent for longer than three months, permanent recovery is very doubtful. If it has persisted for over six months, if more than one-third of the tongue is invaded, if the floor of the mouth is involved, permanent recovery is well-nigh certainly hopeless.

‡ "Recalling the 'male gratus amicis' of Dean Swift. Who has not seen such cases, the close of whose life brings, week after week, days without hope and nights without rest, and has not longed exceedingly for a wider recognition of the pre-cancerous stage of tongue-cancer, and for earlier operations in it?" (*Guy's Hosp. Rep.*, *loc. supra cit.*).

Operations.—The following four will be carefully described, viz.:

(i.) **Whitehead's.**
(ii.) **Syme's** (Fig. 200).
(iii.) **Kocher's** (Fig. 201).
(iv.) **The Écraseur.**

With these, certain aids—*e.g.*, slitting the cheek, preliminary laryngotomy, and ligature of the linguals—will also be considered. One or two other methods will then be briefly alluded to.

While the above operations—and I allude especially to the first three—give a choice which will enable the surgeon to meet any case of tongue-cancer, whichever is chosen must be completely carried out: "niggling" operations lead inevitably to return and accelerated growth in the tongue itself.

(i.) **Whitehead's.**—The advantages of this are very great. They are: (*a*) The transverse section of the body of the tongue can be placed, deliberately, well behind the growth. However far behind the growth the loop of the écraseur is placed before the operation, and however securely it seems to be retained *in situ* by large curved needles, as the loop is tightened up, owing to the enormous strain which is gradually applied, the needles and the loop are forced forwards nearer and nearer to the growth. Now the whole neighbourhood of this is ready to become the seat of malignancy. All around the growth the epithelial columns are ready to dip down into the vascular connective tissue beneath, on which, in health, they never encroach. Again, the parts around are loaded with inflammatory cells, soft and vascular. If, as is very likely, owing to the tremendous tension to which it is submitted, especially when the parts are very soft, the loop comes crushing into this neighbourhood and makes the section here, the indipping processes which extend for some distance around the actual epithelioma may, owing to the vascularity and inflammation consequent on the operation, break out into speedy recurrence. Again, the insertion of the needles which are intended to keep the loop well behind the growth is not always an easy matter, especially if the growth is far back, and if the front teeth are well developed whilst the molars and pre-molars are too deficient to allow of wide opening of the mouth with a gag. (*b*) The resulting wound is very clean, there being very little laceration and no charring. The slight decomposition which would take place from an extensive operation, even with scissors, is readily checked by the use of creolin, &c.

The advantage of this in saving a patient, whose vitality is already lowered, from the depressing effects of being liable for days to breathe and swallow with a fœtid sore in his mouth, in securing rapid granulation and healing, and thus enabling the patient to be early propped up, and soon to leave his bed, must be obvious to every surgeon who knows how great is the risk of fatal septic bronchitis in these cases. For the same reason secondary hæmorrhage is unknown. (*c*) The instruments required are extremely simple and few, as will be seen from the account of the operation.

The Operation.

It is most essential that the anæsthetic should be in the hands of a man who can be thoroughly trusted. It is often taken badly in these cases, with much dyspnœa and restlessness at first; and, during the operation, owing to the open mouth admitting much air, and the fear of interfering with the operator, the patients often "come to" prematurely. The only thing is to get them well under at first; later on it will be well not to keep them too much under the influence of the anæsthetic, in order that, the sensibility of the larynx not being lost, the blood may not enter the air-passages. The administrator must watch the tint of the lips, the veins in the cheeks, and know when a little blood is only safely, though noisily, bubbling at the back of the fauces, and when it is getting into the trachea. I consider the administrator of anæsthetics in these cases to be nearly as important as the operator. Two reliable assistants are needed who understand the steps of the operation, one to take the gag in charge, and to sponge when needed, and the other to hook back the corner of the mouth with two fingers while he is ready to sponge, and thus, with the position of the head over to this side, enable the blood to escape freely from the wound into the cheek and out of the mouth, with the aid of deft sponging. Two nurses should be ready to supply sponges; these being absolutely clean, soft, thoroughly wrung out of iced Condy's fluid, and firmly secured on holders. The following instruments should be close to the operator's right hand—viz., scissors,* a few pairs of Spencer Wells's forceps, curved on the flat, a needle in a handle, threaded with stout silk, and some medium-sized ligatures of sterilised silk.

A good light is absolutely essential. Daylight close to a window is far the best. If it is needful to operate when the above cannot be obtained, as in a succession of foggy November afternoons, a good lamp light, concentrated by a laryngeal mirror, will be useful. In making arrangements for a good light, the surgeon will remember that, while the removal itself takes but a short time, getting the patient under the anæsthetic, and keeping him under its influence, often render the operation much prolonged. It may not be superfluous to add here that this is an operation which calls for coolness and decision on the part of the operator, and for promptness with their help on the part of all those who assist. No crowding on the operator, no obstruction to the light by bystanders, should be permitted for a moment.

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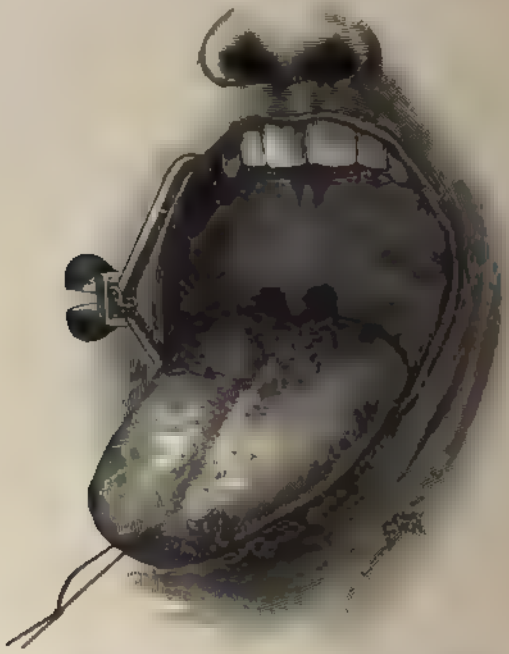
* Mr. Whitehead hearing, in 1881, that I had twice operated by his method, kindly sent me a pair of his scissors. They are rather longer than usual, perfectly flat, very sharp up to the tips, which are square and blunted. Mr. Whitehead's latest account of his operation, with his results in a hundred cases, will be found in *Brit. Med. Journ.*, vol. i. 1891, p. 961. It is no discredit to Mr. Whitehead, who first placed the operation by scissors on a firm basis, to say that Mr. Fiddes, of Jamaica, one of the first surgeons to remove the tongue, used the scissors forty years ago (*Path. Soc. Trans.*, vol. xii. p. [illegible]; *Edin. Med. Journ.*, 1859).

Preliminary Laryngotomy.—The question of the advisability of this operation now arises. It forms no part of a "Whitehead" proper. The operator who introduced the scissors-method, and whose success with it is so well known, never, I believe, uses a preliminary laryngotomy. In my first 6 cases I followed him closely. Among the later 47 I have performed laryngotomy on many occasions. With a wider experience, I am led to think very highly of this preliminary step, and of the plugging of the back of the mouth, which it renders safe, and I do so for this reason. With the fauces plugged, and the patient breathing through a laryngotomy cannula, the surgeon can neglect the hæmorrhage more, can so operate more deliberately, and thus (and this is the value of this preliminary step, in my mind) at every step of the operation can have the parts more thoroughly sponged dry, and consequently is enabled throughout to keep more surely wide of the disease. In other words, I do not dread the hæmorrhage which accompanies a scissors-operation for itself, but because it is liable, in spite of careful and prompt sponging, to obscure the field, and thus lead to cutting dangerously near the growth—a danger especially likely to happen if the hæmorrhage is at all free, if the parts cut are very much softened, and if the patient is not taking the anæsthetic well. For these reasons I am inclined to recommend a preliminary laryngotomy, with plugging of the fauces, in these cases: (1) When a surgeon who values Whitehead's operation is doubtful as to his means of meeting hæmorrhage. (2) When the growth extends beyond the middle of the tongue, into the posterior third. (3) When the floor of the mouth is at all involved. In growths limited to the anterior half of the tongue, unless there is much fixity, laryngotomy is not needed, for, as will be seen below, sufficient of the tongue in such cases, after very little use of the scissors, comes right out of the mouth. (4) This question is also affected by the experience of the anæsthetist. In February 1899, I removed the entire tongue, in a patient sent to me by Mr. Buxton Shillitoe, without performing laryngotomy. But I should add that I had the advantage of Dr. Hewitt's services as anæsthetist. In this patient the growth extended so far back that it would have been difficult to divide the tongue sufficiently widely behind the disease, had there been a sponge in the fauces. At the present time (February 1900) there is no trace of local recurrence; but I have had to remove some glands from both sub-maxillary regions.

If it be decided to perform laryngotomy, this operation is done as at p. 480, and a soft clean sponge, dusted with iodoform, is tied with silk into appropriate size and fixed at the back of the fauces, the silk being brought out of the mouth and held by a finger of the assistant who has charge of the gag. This sponge must be pressed well back, and care taken that it does not draw back and down the base of the tongue, or it may cause some difficulty in securing the linguals when the transverse section of the tongue is made far back. The anæsthetic is now continued through the tube, an additional advantage brought about by the laryngotomy, as the administration of the anæsthetic does not interfere with the field of operation So very little sloughing and swelling of parts follows on Mr. Whitehead's operation, that the laryngotomy-tube may usually be removed as soon as the patient is back in bed and has "come to" comfortably.

Whether laryngotomy is performed or not, the patient, having been propped up, is brought quite to that side of the table on which the surgeon stands. A gag* is placed on the side of the mouth opposite to the growth, and the mouth widely opened. The tongue is then transfixed on the diseased side, well back in its anterior third, with a needle in a handle, loaded with stout silk; this is looped and knotted, and the tongue thus well drawn out of the mouth. The surgeon then, where one half can be spared, with a sharp-pointed bistoury splits the tongue longitudinally along the raphé, to a point thoroughly well behind the growth. It has been said that leaving half the tongue is useless, the

FIG. 198.



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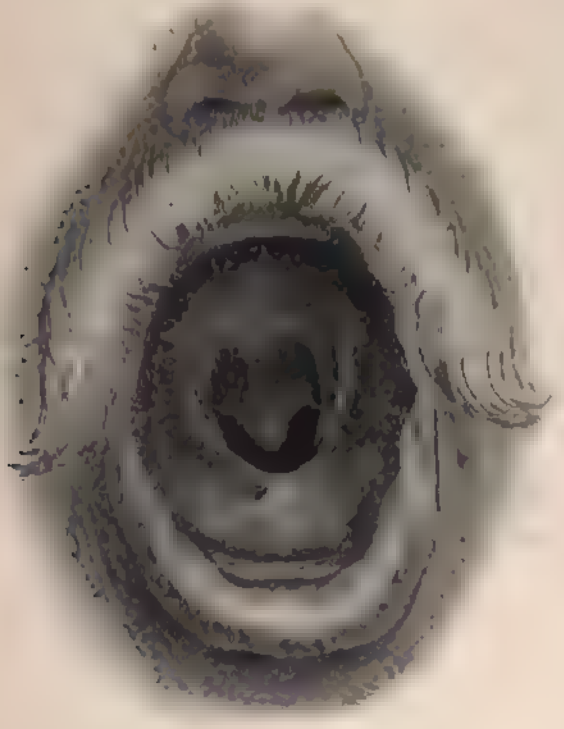
* Of these I prefer Dr. F. W. Hewitt's modification of Mason's gag as the readiest and most efficient in cases where sufficient teeth are present. The patient should be got thoroughly well under the anæsthetic (the degree of anæsthesia being just short of abolition of the laryngeal reflex) I prefer ether first, when the state of the lungs and vessels admits of it, chloroform may be given afterwards with a Junker's apparatus, and a tube through either the laryngotomy wound or the nose. I believe this drug to be quite safe at this stage, and it diminishes the congestion due to the ether. The same well-known and ingenious anæsthetist has lately supplied a want long felt by operating surgeons—viz., a gag that will widely separate the edentulous jaws so often met with in patients the subjects of tongue-cancer (Fig. 199). I refer to Dr Hewitt's wheel-handled gag, made by Weiss.

part left being but little under the patient's control. I am of an entirely different opinion, for reasons given below.

The diseased half or the whole tongue being drawn well out of the mouth by means of a stout silk loop or reliable tongue-forceps, the surgeon next divides with scissors the mucous membrane between the tongue and the alveolar process, keeping close to the bone so as to be wide of the disease. The anterior pillar of the fauces is next divided. While the above steps are taken, an assistant sedulously sponges away any hæmorrhage into the hollow of the cheek and out of the mouth, the cheek being retracted as above directed. Careful sponging, and sponge-pressure on bleeding points, are most essential if the surgeon is to see his way and cut wide of the disease.

FIG. 199.



Condition of mouth a year after complete removal of the tongue in a patient of mine, aged 67. The absolutely edentulous jaws (footnote, p. 454) are to be noted.

If the disease has implicated the frænum and its vicinity, two or three of the lower incisors should be drawn, so that the scissors may be introduced on a level with the disease. If this be not done, the scissors have to be dipped in over the teeth in an awkward way, and one which, as soon as bleeding occurs, makes it impossible to be certain of getting below the disease. The scissors can be introduced with much greater facility, and used to much better purpose, if a gap be made in the teeth. These can be kept, and, later on, fitted to a plate by a dentist.

When half of the tongue has been freed all round, the muscles between it and the floor of the mouth are cut through with a series of short snips until the diseased half is separated on the level of the lower part of the jaw, as far back as is needful. During this stage oozing will take place, and one or two small arteries jet with varying freedom in different cases, but these will yield to pulling steadily on the tongue, and to firmly applied sponge-pressure.

The tongue having been freed horizontally up to a point well behind the disease, the transverse section is now made, and here I have found the following precaution useful: Instead of cutting straight across the half and trusting to being able to secure the lingual on the face of the stump—a step by no means always easy of accomplishment, owing to the artery being often at once obscured by a small pool of blood, and to the not infrequent softness of the tissues in these cases, I cut a deep groove through the tough mucous membrane of the side and dorsum and tear through the softer muscular tissue with the closed scissors or a steel director till the lingual nerve and artery are seen; next, having applied a long-bladed pair of Spencer Wells's forceps to the remaining tissues, cut away the half of the tongue in front of the forceps, and then twist or tie the lingual artery which has thus been secured.*

If it be needful, the surgeon then proceeds to deal with the other half of the tongue, a step which is much facilitated by the room given for manipulation by the removal of the first half.

Removal of Half the Tongue.—On this subject I may quote again from my article in the *Guy's Hospital Reports*, p. 252: "(1) The removal of half the tongue is suitable and strongly called for in certain cases. (2) That such an operation, *performed in fitting cases*, leaves the patient with an organ which is (*a*) safe from recurrence, (*β*) a most useful one in speaking, swallowing, &c. (3) That it is only by operating early in these cases, and by thus being in a position to promise the patient that the less severe operation will be sufficient, and will give him immunity from disease and leave him with a most useful organ, that we shall ever attain to better success in our operations for cancer of the tongue, removal of the tongue being a mutilation especially dreaded and deferred by the patient." Two cases are then given in detail in which I had removed half the tongue. *The condition of the tongue subsequently to removal of one half longitudinally.*—The following short account of the condition presented by the male patient's tongue was written three years after the operation. He remained well nine years later.

On looking into the patient's mouth, the tongue is seen to be directed constantly over to the left side by the unbalanced fibres of the right half, the tip especially being turned round to the left side and a little backwards. The mucous membrane on the floor of the mouth on the left side is, as it always is in these cases, loose and prominent from the constant dragging on it of the remaining tongue. *Mobility.* When the patient is asked to protrude his tongue beyond the lips, there is nothing in the mouth to prevent his tongue from doing so; the tongue is pushed out between the lips, but owing to its tendency to curl round towards the left it does not come beyond them. From the same cause Mr. C. is unable to touch the right commissure of his lips with the tip of his tongue. When asked if he can touch the hard palate with his tongue, he can do so when the teeth are half an inch apart, not when the jaws are widely separated. *Speech.*—Mr. C.'s own account is that he is always intelligible, save when "excited, as in talking politics." His voice is loud and ample. His speech is clear and intelligible, save when one or two consonants, especially two dentals, requiring rapid touching of the incisors or hard palate by the tip of the tongue, succeed each other closely, as in the word "literal." *Taste.*—This, the patient says, is absolutely unimpaired. *Mastication.*—It is here only that Mr. C. allows that any difference is to be noticed since the operation. Thus, in certain actions, *e.g.*, chewing up a bitten piece of apple, manipulating a portion of herring so as to avoid swallowing small bones—in such actions as these he states that "the left half of his mouth does not act as well as the right, the latter having a little more work to do."

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* If any difficulty occur in dealing with a divided lingual, especially if the tongue have been divided far back, a suggestion of Mr. Heath's will be found most useful, viz., to hook one or two fingers into the pharynx over the stump of the tongue, and to draw this forwards, thus at once arresting the hæmorrhage by pressure and bringing into view the bleeding point, which must be tied or clamped with Spencer Wells's forceps.

Where, *in fitting cases*, it is possible, after splitting the tongue, to leave one half of it, this part will be found most useful in speaking, swallowing, &c., and I am further most strongly of opinion that if patients could be assured that, by early operation, half only of the tongue would require removal, they would submit much more readily to an operation which they dread so peculiarly, and to the grievous putting off of which is due the very small percentage of permanent cures. I have spoken twice in this account of removal of half the tongue "in fitting cases." I must repeat this warning clearly and decisively, having recently seen (1899) two cases in which local recurrence had followed on removal of half the tongue, performed by another surgeon, seven and nine months previously. The variety of the disease should here be our chief guide. As is well known to those who have had large experience of tongue-cancer, this disease attacks the tongue in two forms—the *ulcerating*, and the more or less *warty*; the former being, unhappily, the most common. I never remove half the tongue in the *ulcerating* form, unless the ulceration is evidently superficial, or when, especially in a young subject, with perhaps a long life before him, the ulcer attacks the lateral aspect of the posterior third of the tongue, and operating on the wider lines, which I prefer, means removal of the entire tongue. In the *warty* form, growing outwards, and accompanied by only superficial ulceration, if any, removal of one half of the tongue is much more promising.

Slitting the Cheek.—This step is an excellent one. It may be made use of, in men especially, in cases where the disease is situated very far back, extending close to or on to the anterior pillar of the fauces, where the hæmorrhage is expected to be especially free, where the light is unavoidably very bad, or where there is unusual difficulty in getting the jaws well apart.* The cheek is slit as far back as the anterior border of the masseter, the facial artery and other small branches being secured at once. The parts require most careful adjusting afterwards, especially at the corner of the mouth, where, from the dribbling of saliva, primary and exact union is not always secured.

Preliminary Ligature of the Linguals.—This step was very largely practised by Prof. Billroth (*Clin. Surg.*, Syd. Soc. translation by Mr. Dent, p. 113). Unfortunately he expressed no opinion as to its value, merely stating that he ligatured the artery in twenty-seve cases (apparently in all as a preliminary step), that no secondary hæmorrhage ever followed, and that the wound always healed satisfactorily.

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* This long-standing difficulty is now largely met by the invention by Dr. Hewitt of his wheel-handled gag (Weiss).

I have never taken this precaution myself, and I do not recommend it, for the following reasons:—(1) In three cases in which I know of this precaution having been taken, the hæmorrhage was as free as in the usual operation with scissors, performed without any such preliminary.* (2) I think that an experience derived from operations in fifty-three cases justifies me in saying that if the operation with scissors be performed with attention to the details given above, the hæmorrhage is not so difficult to deal with as to require this precaution.† (3) The ligature of both linguals is by no means an operation that can be done quickly,‡ and requires a good light. It may thus take up a good deal of the time required for dealing with the disease of the tongue itself. If it be answered that diseased glands can be dealt with at the same time and by the same incisions, I must state, in no contradictory spirit, that I am of a distinctly contrary opinion. Removal of epitheliomatous glands requires of itself much time and painstaking, lying, as they do, in long chains, and in relation with most important structures. If they are to be removed with that thoroughness which alone justifies any attack on them, this should be done with the full allowance of time and the undivided attention which are given by a separate operation, either before or after that on the tongue (p. 466).

Mr. Treves (*Operative Surgery*, vol. ii. p. 201) is a strong advocate of ligature of the linguals before performing Whitehead's operation for the following reasons: (1) Without it the hæmorrhage is sufficiently copious to hamper the operator. That the hæmorrhage is free with the scissors alone, none will deny. But it may be safely met by a cool and deliberate operator if the patient is kept well propped up, with the head to one side, and the cheek on that side open and retracted. Of the imperative need of a skilled anæsthetist and assistants I have already spoken. (2) That it enables the surgeon to deal with enlarged lymphatic glands, perhaps not to be felt through the skin. I freely admit the importance of this, a matter to which I have drawn attention at p. 466, and elsewhere. Personally, I should prefer to remove the tongue first, and then, if the patient's condition admitted of a further and, very possibly, a prolonged operation, to remove the glands. (3) Mr. Treves states that ligature of the linguals is easy, and that a period of seven minutes is a fair average of the time required to secure each vessel. My reply to this is very simple. The advice I give in this book is not for one moment intended to apply to surgeons of Mr. Treves's operative experience or anything approaching to it.

(ii.) **Syme's Operation**§ (Figs. 200 and 201).—This consists in

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[*] The operations were here performed by two of my colleagues, and there could be no doubt that the vessels were secured.

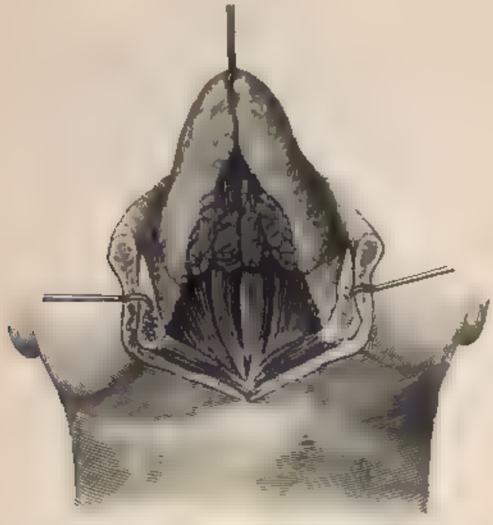
[†] In writing this I am taking it for granted that the surgeon will be aided by helpers as apt and ready as I have been fortunate enough to find.

[‡] The operation is fully described, and its difficulties entered into, at p. 581.

[§] *Lancet*, 1858, vol. i. p. 46, and vol. ii. p. 168. See also the account by Dr. Fiddes of his case, *Edin. Med. Journ.*, vol. ix. p. 1092. As a proof of the severity of this operation dividing the symphysis menti and then removing the whole tongue and floor of the mouth with knife or scissors, or partly with one of these and partly with the *écraseur*.

It is a far more serious operation than the one already given, and often involves prolonged after-treatment, owing to the tardy union of the jaw. It should be reserved for those cases in which the ulcer involves the floor of the mouth, or in which, in addition to an ulcer on the side, a hard mass of infiltration can be felt in the substance of the organ. Where this operation is contemplated in an aged or broken-down patient every attempt should be made to improve the general health previously. An anæsthetic having been given and a preliminary laryngotomy performed, if needful,* the patient's head and shoulders are raised, and the surgeon divides the soft parts of the chin, as far down as the hyoid bone, if the soft parts of the floor of the mouth are much implicated. The vessels being secured, the jaw is drilled below the teeth a quarter of an inch on either side of the middle line, and then sawn through.† The mouth must be kept carefully sponged out, and the halves of the jaw being forcibly retracted, the tongue is well drawn out by a loop of silk, the mucous membrane snipped through between the

FIG. 200.



Removal of the tongue by division of the symphysis of the mandible. (Heath.

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both of Prof. Syme's first two patients died. When the symphysis must be widely removed as well the danger is much increased, chiefly owing to the impossibility of wiring the jaws here and the greater difficulty in taking food.

* As a rule this step is not required When the divided jaws are held well asunder, the blood flows freely out of the mouth.

† By some it is advised to saw this somewhat angularly instead of vertically, to promote interlocking and union of the fragments As, however, necrosis may follow this as well as the other form of bone-section, the longer time that it entails is scarcely worth giving

tongue and the alveolar process, and the anterior pillars next divided. The genio-hyoglossi* and genio-hyoids are now cut through, and the tissues in the floor of the mouth separated as deeply as necessary with the scissors or blunt-pointed bistoury aided by the finger, partly by cutting and partly by tearing, any vessels that require it being tied with silk. The tongue being thus freed laterally and below as far back as is needful, the transverse section is made, one half at a time, with the precautions recommended at p. 456.

The floor is now carefully inspected, and any suspicious patches or enlarged glands most carefully removed. In raising the former before using the scissors, a sharp hook is often very useful. If it be preferred, though I in no way recommend it, as soon as the attachments of the tongue to the floor and sides of the mouth are sufficiently divided, the transverse section can be made with an écraseur, the loop of which is slipped over the tongue and kept in position by two curved needles as at p. 463. The tongue is first slit

The two halves of the jaw can then be wired, but to promote speedy union a cap of vulcanite or silver should, later, be fitted on to prevent displacement of the fragments. A drainage-tube should be brought through from the mouth to a point just above the hyoid bone, before the soft parts are united with sutures.

(iii.) **Kocher's† Method by Lateral Infra-maxillary Incision** (Fig. 201).—This operation, like the last, is a severe one; it also opens up freely the connective tissue of the neck. It is said to have the great advantage of enabling the surgeon to deal with mischief far back in the tongue and at the same time to remove enlarged sub-maxillary glands. The statement that the operation can be performed aseptically must be received with much caution. It is impossible to cleanse thoroughly the naso-pharynx, antrum, and other regions which lie near, and the plugging of the nostrils with aseptic wool and packing the wound with gauze, which will need changing, involve much discomfort to the patient. The mouth being disinfected with 1 in 3000 perchloride of mercury solution, and a preliminary laryngotomy performed, an incision is made from just below the symphysis down to the hyoid bone, and following the digastric muscle back to the anterior edge of the sterno-mastoid, then up to near the lobule of the ear. The flap thus marked out of platysma and fasciæ is turned up, and the facial artery tied. The sub-maxillary region is then thoroughly cleaned out and the lingual artery secured beneath the hyoglossus. By cutting through the mylo-hyoid muscle the cavity of the mouth is now freely opened into, and the tongue brought out through the wound and divided as far back as is needful, one half being removed after splitting the organ, or the whole tongue removed, the opposite lingual being tied if needed.

The large wound is then carefully packed with strips of antiseptic gauze, a drainage-tube being first inserted. The patient continues to

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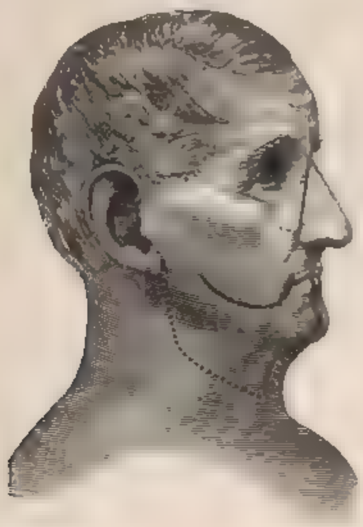
[*] If only one half of the tongue needs removal—a rare contingency in the cases which call for this operation—the complete separation of these muscles and the consequent danger of the falling back of the tongue will alike be avoided.

[†] *Deut. Zeitsch. f. Chir.*, Bd. xiii., 1880. Mr. Barker was the first, I believe, to draw the attention of English surgeons to this operation ('Diseases of the Tongue,' *Syst. of Surg.*, vol. ii.).

reathe through the laryngotomy-tube until the wound and mouth are aite sweet and thus there is less danger of septic broncho-pneumonia.

If it be desired to conduct the operation as strictly antiseptically as ossible, before it is begun plugs of salicylic wool must be placed in the ose, the cavity of the mouth well washed out with 1 in 3000 mercury erchloride solution, and irrigation used at the operation and at each ressing. As, however, it is impossible to render aseptic the closely ontiguous cavities of the posterior nares and pharynx, and as the atient will require feeding at regular intervals with a nasal tube, I ould prefer to trust to sufficiently frequent changes of the gauze with hich the wound is plugged, painting, with a camel's-hair brush, iodoorm and ether or turpentine, and securing absolutely free drainage by drainage-tube which has one end brought out of the mouth and the other at the lower and posterior angle of the wound, both lodged in aseptic dressings.

FIG. 201.



The incisions on the nose are those of Ollier for the removal of naso-pharyngeal fibromata, p. 389. Below are seen three for the removal of the tongue—viz., that for slitting the cheek, and that of Syme's operation. The third is that of Kocher, the lateral infra-maxillary incision.

Several English surgeons have lately drawn attention to Kocher's method, already alluded to, of packing the wound with antiseptic gauze and bringing a drainage-tube out into the sub-maxillary region. Mr Watson Cheyne, in his very instructive Lettsomian Lectures (*Lancet*, vol. i. 1896, p. 467), thinks that Kocher's operation, with thorough removal of the glands and the muscle down to the hyoid bone, becomes requisite when the cancer extends deeply into the substance of the tongue, and more especially when it is situated at the back part. I agree with Mr. Cheyne that in such cases, with cancer of the back part of the tongue and glands already enlarged, Kocher's operation is justifiable. Personally in such cases I prefer to remove the tongue at one operation, lifting it well up from the mouth as the floor is cut through, so as to divide the muscular tissue as far from the disease as possible. The cheek should be slit in cases where the disease extends far back. Deep-seated ulceration of the tongue is, in my experience, rare at the present day, though it was common enough thirty years ago. When it does occur the subjects of it are rarely suited to undergo an operation so severe as that of Kocher. I admit that the delay of a fortnight (for the glands cannot be attacked sooner) is not a light matter, but the disadvantage of waiting is in part compensated by the additional time which can be given to the two operations.

I have not myself made use of this method, for these reasons: I consider (1) that other means give as good results, and in a way more agreeable to the patient. I ought to add here that, out of fifty-three cases of Whitehead's method, I have lost six* patients from the operation. Many of these were extensive and very severe cases. Out of nine other cases in which, in addition to most of the tongue, part of the jaw was removed, I have lost four from the operation itself. (2) That this method of packing with gauze does not, and cannot, give absolutely reliable aseptic results. It would, I think, be easy to prove this from the constant soaking of saliva and other matters, in which this wound differs from others, but no better proof can be given than the fact that a patient on whom Mr. Butlin himself made trial of this method died, on the eighth day, of septic pneumonia.

(iv.) **The Écraseur.**—This may be used in different ways; the two following are the chief ones:

1. Through the mouth, in combination with scissors—a method used by the late Mr. Morrant Baker.†
2. By means of a puncture in the sub-maxillary region, or through a wound which has to be made here in the removal of enlarged glands.

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* The first of these was a Jew, prematurely aged, with epithelioma supervening on syphilis, who died, on the eighth day, of broncho-pneumonia. I fear that this was septic, though my colleague, Dr. Mahomed, who saw the patient during life, and who made the post-mortem examination, was of a different opinion—being influenced, chiefly, by the sweet condition of the mouth. In the second case, that of an itinerant musician over 50, much broken down by poverty, exposure, and drink, I had removed the tongue far back for extensive epithelioma. The patient was left in bed, with orders that he should be carefully watched. For some reason these were not carried out. On my return in an hour's time I found him with his mouth full of clot, and a porringer half filled with bright blood. This was oozing from a vessel in the floor of the mouth close to the left alveolar arch. As the patient was most unruly, I had ether given for a few minutes, while the vessel was secured. No further bleeding took place, but the patient never "came to" properly, dying about sixteen hours later. His lungs were the seat of old broncho-pneumonia, and his kidneys showed advanced fibroid change, but the additional shock of the hæmorrhage and some blood in his lungs were undoubtedly the causes of death. Broncho-pneumonia carried off the third and fourth cases. The fifth, the subject of long-standing and severe syphilis, died thirty-six hours after the operation. In this case I had unwisely removed epitheliomatous glands at the same time. The sixth, an old lady of 79, with extensive tongue-cancer, died on the eighth day after the operation, from debility and the impaired vitality of her age.

† *Lancet*, April 10, 1880; *Dict. of Surg.*, vol. ii. Mr. Hutchinson (*Brit. Med. Journ.*, 1891, vol. ii. p. 1247) is a very strong advocate of the wire écraseur. His success, it must be remembered, is largely explained by the facts that a great number of his cases have been partial excisions, and many of them operations on private patients. It is well known how strongly Mr. Hutchinson has advocated early operations.

The first of these only will be described here, as, if the écraseur has to be made use of, it is by far the simplest and speediest method of using it.

In addition to the instruments already given in the description of the operation with scissors, the surgeon must be provided with a stout, short écraseur, curved on the flat, working smoothly and carrying a strong loop of whipcord, not of wire.*

The first part of the operation resembles that given at page 452. The tongue having been well drawn out with a silk loop, and the anterior pillar and the mucous membrane between the alveolar margin and the tongue cut through, the tongue is split with a bistoury along the raphé as far back as is needful, and its attachments to the floor of the mouth partly snipped through with scissors, partly torn through with the finger. The tongue being now freed sufficiently to make the transverse divisions, two slightly curved needles, in handles, are made to perforate the tongue a full inch behind the posterior limit of the disease, and the loop is then slipped on and adjusted behind the needles. Before doing this, I would strongly recommend that a groove be cut with the scissors through the mucous membrane of the dorsum and sides of the tongue (p. 456); this simple step will serve to steady the bite of the écraseur and lessen the risk of its gradually coming, as it is tightened up, dangerously near the growth, and it will also shorten the time that the loop takes to effect its work. When first adjusted, the écraseur may be worked more quickly, but as soon as real resistance is felt the screw must be turned more slowly, a half or three-quarter turn being made every minute, or at longer intervals if the loop seems to be cutting too quickly. To avoid bleeding, and snapping of the wire, the tightening of the loop, when once buried, must be very deliberate (Hutchinson), the operation taking from half an hour to an hour. If oozing take place from hurried use of the écraseur, it will be far more difficult to arrest on a surface bruised by this instrument than on one clean cut by scissors.

When the whole tongue is removed, the écraseur should always be applied to each half separately. Making the transverse section across the whole tongue at once is most tedious, and the great strain is likely to be too much for the loop or instrument itself. It also causes the constricted tongue to swell into a large livid mass, which much obstructs the breathing; and if, as is likely, both the linguals, which are left to the last, are divided simultaneously, the furious spurting of these vessels in two crossing streams is most embarrassing (p. 464).

I do not recommend the use of the écraseur, for these reasons:

1. However well behind the disease the loop is placed at first (a step by no means easy to secure where the disease is situated far back), as it is slowly tightened up it tends to come forward (even when a groove

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* Mr. Butlin (*Dis. of the Tongue*, p. 334) gives the following case: The only instance of death from hæmorrhage "in my table occurred in the case of a man whose tongue was removed with a strong wire écraseur, which cut through the tissue of the tongue like a knife, much more quickly and cleanly than had been intended. There was some smart hæmorrhage at the time, and it was not easy to get the man out of the operating-theatre alive. The artery was not thoroughly secured, the bleeding recurred, and the patient sank and died a few hours later."

has been cut in the mucous membrane), gradually grinding the needles placed to keep it in position and the loop closer and closer upon the diseased area, or, if not actually into this, into one which from its close contiguity, is ready to take on disease.

2. I have seen again and again, however carefully the tightening of the loop has been managed, that this is, finally, not fine enough to divide the lingual artery, which is dragged out in the eye of the loop and has, after all, to be secured by ligature or torsion, often not without previous furious bleeding.

The *galvanic écraseur* has not been described. I mention it here only to condemn it. During the operation the loop may break, or it may cut its way too rapidly through the softened tissues, especially if the heat used be too great. Later on, the patient has still to run the gauntlet of the risks of septic lung-trouble and secondary hæmorrhage which the use of this treacherous instrument entails.

CANCER OF THE TONGUE AND OTHER PARTS AS WELL.

Question of Operation.—These cases, in which it is most difficult to decide aright, fall mainly into **two groups.**

A. Where the epithelioma is situated far back, affecting the tongue, tonsil, palate, and perhaps the posterior part of the body of the jaw.

Here the cancer affects a region very rich in lymphatics, and invasion of the glands will probably take place early. For this reason permanent successes are practically unknown here, though operations are, from time to time, published as successes, within a few weeks or months of their performance.

In deciding upon operation the surgeon will be guided first by the age of the patient, the natural expectation of life, the vitality and power of recovery, and the state of the viscera, especially the lungs.

Then he will investigate carefully into the following points: How far the epiglottis or the upper aperture of the larynx is involved;* whether the secondary growth of the tonsil and its pillars is hard and fixed, or movable on the parts beneath; whether the pharynx itself is involved. Next, if there is enlargement of the lymphatic glands, their extent, fixity, and how far any softening or breaking down is already present.

The last two will usually decide against operation in these cases, and as to extent, I will only say that here and in all kindred cases epitheliomatous enlargement of glands in the posterior triangle, and especially of those under the upper third of the sterno-mastoid, renders operative interference with the glands hopeless as to permanent success.

If an operation be decided upon, the points fully dealt with in Chapter xi. p. 473 will be found helpful.

B. In this group the epithelioma has attacked the chin and fore part of the tongue and the floor of the mouth. Here the outlook is better as to a permanent cure, owing to this part being less richly supplied with lymphatics.

All the affected parts must be removed unsparingly, and the resulting deformity is very great.

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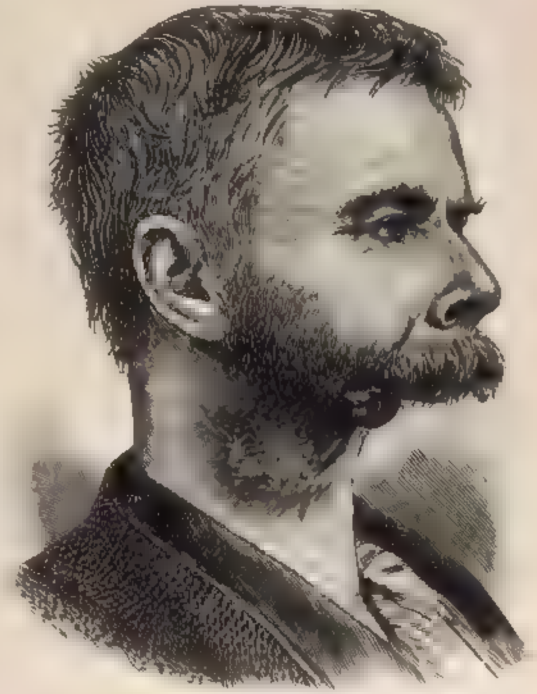
* Cocaine or, where the mouth is closed, a general anæsthetic may be required to clear up this point.

Fig. 202 shows this well, and is also a good instance of the fact that occasionally, when occurring on a superficial surface, and one which dries quickly, epithelioma ulcerates slowly for a time.

The patient, a man aged 33, had been originally operated on for epithelioma of the lip at a hospital in the South of England. The disease recurred, and gradually invaded the symphysis menti and front of the tongue and the floor of the mouth. The case was a distressing one, on account of the large foul sore prominently in view, the filthy smell of the discharge, and the neuralgic pain constantly present due to the disease having involved both inferior dental nerves. The man had been seen by two other London surgeons, and operation had been advised against owing to the very small chance of a permanent cure, and the deformity which was certain to follow on the operative interference necessary. As no enlarged glands could be felt, and as the patient, young himself and healthy otherwise, had a young wife and child, I left the decision to him, after putting the two sides of the question clearly before him. He decided to run the risks. At the operation, performed by curved incisions carried out from the angles of the mouth on to the cheeks, then across the sub-maxillary regions to the anterior border of the sterno-mastoid, and thence running inwards to meet at the hyoid bone, healthy tissues were cut through, but it was quite impossible to provide adequate flaps. It was necessary next to saw the jaw through just in front of the masseter on each side, as sections in front of this point showed that the inferior dental canals were invaded by the growth. While a finger in the mouth carefully defined the extent to which the floor and soft parts were invaded, as shown by the induration—no ulceration, happily, having taken place here—the diseased structures, including the anterior half of the tongue, were cut away with a wide margin of healthy tissue. All hæmorrhage having been arrested and drainage provided, the skin on either side was brought together as far as was possible. No epitheliomatous glands were found. The patient made a good recovery, his chief trouble at first being inability to take any food at all, which necessitated feeding him with a tube, and the pain caused by the sawn fragments moving in inflamed soft parts with any spasmodic action of the muscles. At the present time, nearly three years after the operation, he is free from recurrence. The chief drawbacks to his lot, in addition to the necessary deformity, are that he can take no ordinary solid food, that his power of speech is extremely limited owing to the loss of his lower lip and the way in which the stump of the tongue is tied down in the scar, and the constant dryness of his mouth. He is able to work at

Fig. 202.



home, making hen-coops and the like. His wife has borne him a second child, now six months old. If he continues to have no recurrence of the growth, it might be possible to close in the gap by means of a flap taken from the arm.

Removal of Glands.—I have already, at p. 449, drawn attention to several points that are of the greatest possible practical importance with regard to the invasion of the lymphatic glands in epithelioma of the tongue. **With regard to operations** here **two questions** arise for answer:—A. Should a routine operation be performed for removal of the lymphatic glands in every case, just as in the operation usually performed for cancer of the breast, whether the glands can be felt or no? B. How far are later operations on the glands justified, in cases in which they are noticed to be enlarged some time after the operation on the tongue.

A. *The advisability of removing the glands in every case, as a matter of routine.* I advocate this step very strongly on the following grounds: (1) We can never tell in what cases invasion of the glands will follow. That it follows in a great number, and in many apparently most favourable cases, is certain. Mr. Butlin (*loc. supra cit.*, p. 543) puts the percentage as follows:—"About 70 per cent. of the cases can be so successfully treated by operation that there is little fear of recurrence *in situ*; but of these seventy persons probably thirty will die, perhaps as many as forty, of affection of the glands of the neck." 2. We do know (*a*) that infection of the glands begins here almost from the day that the ulcer assumed suspicious features, (*β*) that the same infection may be started by ulcers of the smallest size and of but brief duration. (*γ*) That deposits of epithelioma may here remain latent in the lymphatic glands for two years certainly, and then evoke disease. (*δ*) That gland-infection is here not only certain, and often early, but peculiarly baneful (p. 449). 3. The neck is a part which lends itself readily to healing, and with scars that are ultimately not very disfiguring, especially in males.

For the above reasons exploration of the anterior triangle and removal of any enlarged glands should always be urged as a matter of routine on patients with cancer of the tongue, and especially in hospital patients, owing to the more advanced stage of the disease often met with in them.* By adopting this routine practice, no doubt, a few needlessly extensive operations will be performed, as in the case of the breast. But with cancer of the tongue, as with cancer of the breast, we do not know, and have no means of diagnosing, the few cases in which the glands will not become involved. Hitherto we have too much left this question to chance: the result has been that many most successful operations on cancer of the tongue have been rendered fruitless by the reappearance of cancer in the glands, which at the time of the primary operation appeared perfectly healthy. The operation should be performed three or four weeks after that on the tongue, according to the severity of the primary operation and the recovery of the patient. The anterior triangle should be exposed in the fullest way by an incision along the whole length of the anterior border of the sterno-mastoid and another meeting the first at the angle of the jaw and running to the symphysis

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* When the operation is refused the patient should, if possible, be kept under regular observation at short intervals.

The three chief groups affected are the sub-maxillary, the sub-mental, nd the deep cervical.* The sub-mental is often overlooked. The sub-maxillary group can only be extirpated by removal of the sub-maxillary alivary gland, in which lymphatic glands are often embedded. The condition of the deep cervical should be explored by following downwards the whole length of the carotid sheath as far as it is accessible.

B. *Advisability of operating on enlarged glands at a later date,* i.e., *ome time after the operation on the tongue.*—While this step must be aken sometimes, it is done under much less favourable conditions. There are few more difficult questions to decide than those which arise n these cases. The patient, maybe in the prime of life, with a soundly healed scar in his mouth, comes again to the surgeon, perhaps after a ong disappearance, with infected cervical glands, and urges further peration. Each case must be decided upon its own merits. I will nly urge the following upon my younger readers. 1. It is not the east use operating when the uppermost deep cervical glands are nvolved, *i.e.*, those under the upper third of the sterno-mastoid, eaching to the mastoid process behind, and the angle of the jaw in ront, and into the pterygoid region. 2. Operation will be futile a) when any of the infected glands are soft and breaking down p. 449); (β) when both anterior triangles contain enlarged glands.

After-treatment.—The chief objects here are: (1) to keep the wound sweet; (2) to give sufficient food.

The treatment I have made use of is as follows:—For some days before the operation I make the patient practise† frequently washing out his mouth with Condy's fluid, sitting up, and with the head lternately dependent to either side. He also gets used to feeding himself with a drainage-tube attached to a feeder-spout and passed by himself to the back of his throat.‡

After the operation the cut surface is brushed over with a strong olution of zinc chloride (gr. x.—℥j.), or iodoform in ether or turpentine 1 in 8); ice is given to suck, and milk and brandy and beef-tea are dministered either by a soft œsophageal tube or by enemata, or both. But I have generally found that, after the first six hours, a patient previously practised in the matter will give himself sufficient food.§ A glass of pale ale is, usually, early acceptable.

After the patient has had his first sleep the surface is brushed over, very two or three hours at first, with formalin, and he is soon ncouraged to sit up and wash out his mouth constantly with carbolic cid (1 in 60 or 80), a wash of a tablespoonful of spirit of wine in a umbler of water (Hutchinson), or Condy's fluid. It is not the wash hat is of so much importance as the frequency and painstaking with which it is used. From time to time the stump is painted over with ormalin, a solution of creolin, or the following wash: a saturated

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[*] Mr. Butlin adds the parotid. But infection of this gland is, I think, rare, and hen the parotid is involved the secondary deposits are too extensive for removal.

[†] This gives him something to occupy his mind, and cleanses his mouth. The teeth hould also be thoroughly cleaned.

[‡] If the patient is at all intelligent, he will do this for himself far more painlessly han an assistant can.

[§] If this is not the case, a soft tube must be passed.

solution of iodoform in ether with one volume in ten of turpentine added (Whitehead). The patient should be kept warm and free from draughts, and propped up or turned on to either side alternately. I try to induce my patients to sit up a little on the second day if possible, and get them, when this is feasible, into an arm-chair a day or two later. Yolks of eggs, arrowroot, soups, pulped vegetables in broth, ale or stout, and such like, are, as soon as possible, taken in addition to the milk and brandy and beef-tea.

Causes of Failure.

(1) Broncho-pneumonia. Pneumonia. Abscess and gangrene of the lungs. These must be placed first on account of their frequency. Septic in their nature, and due to the patient breathing foul gases and drawing down putrid fluids into his lungs, the treatment must be preventive, every endeavour being made to keep the mouth sweet and to relieve the patient's breathing by attention to the details already given.

(2) Hæmorrhage. This is rarely met with at the time of the operation or soon after, if every spurting artery has been properly secured.

I have alluded to one case in a footnote at p. 462. The only other case in which I have met with troublesome bleeding was one in which I had removed the tongue immediately in front of the epiglottis, in a gentleman of 63. Some difficulty had been met with in securing the left lingual. Half an hour after the completion of the operation, blood began to well up into the mouth on the left side, the bleeding point being just out of sight. Being alone with the patient, I arrested the hæmorrhage first by adopting Mr Heath's suggestion (footnote, p. 456), and then luckily succeeded in clamping the bleeding point with a large curved pair of Spencer Wells's forceps. These the patient, a man of great courage, kept in place for twenty hours. No bleeding followed on their removal. The patient made an excellent recovery, and remains well, but only fourteen months have elapsed since the operation.

Hæmorrhage will also be rarely met with as a secondary complication if the wound has been kept sweet. In cases of bleeding, if the application of a silk ligature to the bleeding point taken up by a Spencer Wells's forceps or a tenaculum is impossible, firm pressure with a sponge (on a holder) should be made use of after all clots have been removed. If the wound has been allowed to become foul, it must be cleansed by brushing it over with iodoform and ether, or with turpentine—a most powerful cleansing styptic,* and one always to be used in preference to perchloride of iron. If all the above fail, either applying and leaving *in situ* a pair of Spencer Wells's forceps, packed around with soft gauze, or ligature of the lingual, must be resorted to (*q.v.*).

(3) Cellulitis. Erysipelas. (4) Pyæmia. (5) Exhaustion—more rarely, shock. (6) Œdema of the glottis. (7) Suffocation from falling back of the tongue. (8) Recurrence. I have spoken fully of the gravity of this complication at pp. 449 and 466. For the first year after the operation every patient should come under skilful supervision at intervals of a month and no more.

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* See the remarks on a case of ligature of the occipital artery. If the bleeding is of the nature of oozing, one or two injections of ergotin should certainly be tried.

CHAPTER XI.

OPERATIONS ON THE TONSIL.

REMOVAL OF NEW GROWTHS OF THE TONSIL.

THE new growths here are most commonly round-celled sarcomata and epitheliomata.

In sarcomata, in adults, there is a steady enlargement of one tonsil, without, at first, pain or inflammation; a globular swelling, the size of a walnut, appearing firmly elastic, tending to infiltrate adjacent structures, and fungate as a sloughing mass into the mouth.

In the epitheliomata the patients are older; the mischief often begins as "a sore throat." The mass occupying the site of the tonsil is now much harder and soon ulcerates, forming an excavated ulcer with the characters of epithelioma, and soon implicating adjacent parts. The base of the tongue may be involved secondarily. Dysphagia, emaciation, &c., are more rapid here.

Before describing any operations for removal of tonsillar growths, it is right to allude to their great malignancy, owing to the rapidity with which the glands are affected both in epithelioma and most of the sarcomata. In this, rather than in the importance of its relations, lies the failure of operations on the tonsil, and no one who has watched the rapidity with which (owing to the intimate connection between the tonsil and the lymphatic glands) enlargement of the glands at the angle of the jaw takes place in subacute tonsillitis will wonder at this. Diagnosis at the earliest possible moment is of the greatest importance here.

Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 174) writes on this malignancy: "The disease proves fatal, in very many instances, within a year or even six months of its first appearance; indeed, few persons survive for more than three-quarters of a year."

Dr. Newman (*Malig. Dis. of Throat and Nose*, p. 158), writing of sarcomata of the tonsil, considers that "by far the most common variety is the round-celled sarcoma, or lympho-sarcoma, a most virulent disease, and one in which secondary formations develop rapidly." The same writer (*ibid.*, p. 176) draws a distinction here which may have some practical importance. While admitting that round-celled sarcomata quickly invade the glands, he points out that the spindle-celled sarcomata may remain limited within a capsule, and so be capable of complete removal.

hus, in one case of Dr. Newman's the patient lived five years after emoval of a spindle-celled sarcoma through the mouth, and then died rapidly owing to disease appearing in the opposite tonsil.

Operations.

A. Through the Mouth. **B. By Incision in the Neck.**

Whichever method is chosen, the selection of cases here for operation must be a very careful one, owing to the great malignancy of these growths, and the advanced stage which the disease has often reached.

CASES FAVOURABLE FOR OPERATION.—Where the growth is still small, hard, localised to the touch, well defined, still movable, free from ulceration, and where no enlarged glands can be made out. On the other hand, where the swelling in the mouth is continuous with one in the neck, each diffuse and ill-localised, and the primary growth showing a friable, sloughy, ulcerated surface, operation will be probably contra-indicated. Gastrostomy, as a palliative step, may here give some relief. In intermediate and doubtful cases, as where one or more enlarged glands exist, but still separate and mobile, the surgeon will be quite justified in giving his patient a chance, knowing the distressing future if the growth be left—the agonising earache, the dribbling of fœtid saliva, the dysphagia, &c.

A. Through the Mouth alone.—This method can only be made use of in a very early stage of tonsillar new growths, when the disease is limited to the tonsil itself, not implicating the adjacent pillars, and when there is not the least evidence of glandular enlargement.

If the following operation seems somewhat severe, the infiltrating tendency of growths here must be remembered.

The patient's head having been suitably raised and supported, in a good light, the cheek on the affected side is divided from the angle of the mouth to the masseter, and the two ends of the facial artery tied or twisted. The mouth is now kept widely open by a gag (p. 454) inserted on the opposite side, the tongue drawn out of the mouth, and the masseter pulled backwards by a retractor. As much room and light as possible being thus obtained, the surgeon, dragging forward the growth with an efficient forceps or vulsellum, divides the soft palate first in the middle line, and then from within outwards with scissors; he next, either with the same instrument or with a blunt dissector and his nail, dissects around and carefully enucleates the tonsil with the pillars. The whole operation should be slowly and deliberately carried out, the surgeon cutting wide of the growth and encroaching on the tongue, &c., if needful. He thus remove the growth together with a margin of healthy tissue, and give his patient the best chance. Mr. Butlin points out that some of t new growths met with here are so easily separable, so circumscrib if not encapsuled, that there is not the least difficulty in shelling th out.* Bleeding will be best arrested by temporary forci-pressure firm sponge-pressure.

Some surgeons, where the growth is at all cauliflower-like i prominence, remove the chief part first with a heated wire or the Paquelin's cautery, so as to get more room in dealing with the base, or do the whole operation with the cautery instead of the scissors. In either case the cautery must be used at only a dull red heat for fear of hæmorrhage. The surgeon must be prepared for its leaving indurated tissues which may simulate deposits of growth, and for the tendency of the instrument, as it is quickly cooled down by its contact with succulent tissues, to stick to them. A little additional heat frees it at once, far more satisfactorily than pulling it away. The objections to the cautery are—(1) that it requires a special instrument, which may not be at hand; (2) it introduces sepsis; (3) with it, it is very difficult to judge aright of the nature of the surfaces divided, whether sound or infiltrated; (4) it necessitates the use of chloroform, which may be inconvenient. For these reasons the use of the cautery, if it be employed at all, should be limited to searing thoroughly the surface of the wound.

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* *Loc. supra cit.*, p. 175. Mr. Butlin allows that recurrence is, unfortunately, robable after shelling out. I prefer the method of removing widely.

The after-treatment will be similar to that given at p. 467.

B. By Incision through the Neck. Lateral Pharyngotomy.

(1) *Cheevers' Method.*

Where enlarged glands exist, or where the surgeon is anxious to define and draw aside the important structures which lie outside the tonsil, this method will be employed, either alone or in conjunction with one inside the mouth.

The following account of the above method, somewhat modified, is taken from a case of Mr. Golding Bird's:[*]

An oblique incision was made from the lobule of the left ear, downwards and forwards, to the hyoid bone. The superficial structures and deep fascia were divided, a branch of the external jugular vein alone requiring ligature. An enlarged lymphatic gland was shelled out and the digastric exposed. This and the stylo-hyoid were then divided, and a second hard gland being found, it was also removed; it lay against the internal jugular vein. On retracting the posterior border of the wound and pulling forwards the angle of the jaw, the stylo-glossus and stylo-pharyngeus were seen and divided, fibre by fibre, on a director. Neither the hypoglossal nerve nor the glosso-pharyngeal was observed. The fascia investing the posterior part of the sub-maxillary gland was slit up, and the facial artery ligatured and divided. The internal jugular vein was now fully exposed for more than one inch. The internal carotid was not seen, but, covered with fascia, was felt pulsating. These two vessels being drawn outwards by a retractor, the wall of the pharynx was, by tearing through some yellow fat, fully exposed, bulging to and fro with the respiration. No vessel save the two already named required securing; and at the upper part of the wound was what appeared to be the pes anserinus. A second incision was now made through the cheek from the angle of the mouth[†] towards that of the jaw. There was no hæmorrhage, as the facial artery had already been secured. With the left forefinger in the mouth and the right in the wound, the enlarged tonsil could easily be moved between them, and it was removed, together with the adjacent piece of the pharyngeal wall, by the electric cautery, employing this partly as a knife and partly as an écraseur.[‡]

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[*] *Clin. Soc. Trans.*, vol. xvi. p. 9. The case was one of epithelioma, in a patient aged 45.

[†] In Cheevers' method the first incision is made along the anterior border of the sterno-mastoid, the second incision along the horizontal ramus of the lower jaw, and the flap thus marked out thrown down. This gives more room for the subsequent dissection (especially in a stout patient), and is more likely to expose enlarged glands. The incision through the cheek might be made as well, later on, as in Mr. Golding Bird's case.

[‡] Mr. Golding Bird, in his remarks on this case, stated that in another case he should

The patient made a very good recovery, air ceasing to pass through the wound in the neck on the sixteenth day.

In spite, however, of the thoroughness of the operation the disease recurred in the glands within six weeks, and within two months it returned in the throat as well.

The following remarks of Mr. Golding Bird deserve careful consideration. Admitting the feasibility of the operation he says: "The question of expediency, however, demands the fullest attention, and I am inclined to think that the plan adopted in my second case referred to—namely, feeding by a soft œsophagus-tube, with the alternative eventually of performing gastrostomy—more likely to meet all the real requirements of these cases, unless seen so early that there can be no suspicion of the growth having extended beyond the tonsil, nor of having invaded the lymphatic system except to a very limited and remediable extent."

The account of the next two operations is taken from Mr. Butlin (*loc. supra cit.*, pp. 176, 177).

(2) *Czerny's Method.*

A preliminary tracheotomy having been performed, and the larynx or fauces plugged, an incision is made downwards and outwards from the angle of the mouth to the anterior border of the masseter, and beyond it to the level of the hyoid bone. Through this incision the lower jaw is exposed and sawn through, between the second and third molars, from above downwards and outwards, in the line of the superficial incision, and the two fragments are held widely asunder. The growth is by this means laid bare, and, to remove it, it may be necessary to divide the digastric, stylo-hyoid, stylo-glossus, buccinator, and superior constrictor muscles, and the hypoglossal, glosso-pharyngeal, and gustatory nerves, as well as the lingual and other vessels. The growth is then cut or torn out, and the bleeding points are touched with the cautery. The wound is thoroughly washed out with carbolic lotion, or dusted with iodoform, the fragments of the lower jaw wired, a second wire twisted round the adjacent molars, and the external wound closed with sutures except at points for the exit of drainage-tubes.

(3) *Mickulicz's Method.*

This is intended to be even more radical than that of Czerny. An incision being made from the mastoid process downwards and forwards, along the anterior border of the sterno-mastoid, as far as the great cornu of the hyoid, the soft parts are raised from the jaw, the facial nerve being preserved if possible, and the periosteum is separated from the outer and inner aspects of the jaw, just above the angle. The jaw is then sawn through beneath the periosteum, the tendon of the temporal divided, and the greater part of the ascending ramus resected. After drawing aside, with strong hooks, the body of the jaw, the masseter, internal pterygoid, digastric, and stylo-hyoid, Mickulicz found that the surface of his wound corresponded as nearly as possible with the region of the tonsil, and, by dividing the lateral wall of the pharynx he obtained access to the palate, the base of the tongue, and the posterior

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open the pharynx with scissors, owing to the difficulty which the use of the cautery creates in knowing whether the required depth has been reached in the extirpation of the growth.

wall of the pharynx as far up as the naso-pharynx; and by dividing the digastric muscle and the hypoglossal nerve, he could reach the entrance of the larynx. Mickulicz prefers to do a preliminary tracheotomy, and claims for his operation, not only ease in reaching and removing the disease, and in dealing with lymphatic glands, but, further, that the whole wound communicates freely with the outside, and can be dressed antiseptically. So far from the resection of the ascending process being a disadvantage, it offers the positive advantage of giving more mobility of the jaw than is otherwise present after the contraction of the scar which results from any of these operations.

Mickulicz's patient was a woman, aged 65, and the disease had existed about four months. She recovered, and remained well for two years, when recurrence appeared in the glands.

C. **Combined Operations of Slitting the Cheek and Lateral Pharyngotomy.**—Bergmann, Küster, and Polaillon have operated on these lines. The principle of these operations is an incision passing from the corner of the mouth to the angle of the jaw, and then along the anterior border of the sterno-mastoid as far as is necessary. The jaw is sawn through at its angle, and the fragments widely retracted, and more or less of the ascending ramus is resected. Langenbeck makes use of an incision passing from the angle of the mouth across the cheek, and then down over the jaw, just in front of the masseter, into the anterior triangle. The jaw is sawn at the site indicated above.

Choice of Operation.—Where the growth is no longer quite small, where it is not limited to the tonsil itself, where there is any enlargement of glands, or where the existence of this, though not certain, is, from the duration of the case or the presence of ulceration, very probable, lateral pharyngotomy, with or without incision of the cheek, should be performed. It gives free access to the tonsil and adjacent parts, it enables the surgeon to have the important vessels of the neck retracted, it admits of a simultaneous removal of enlarged glands, and putting a temporary loop upon the common carotid (*q.v.*), or ligature of the external carotid, or trusting to securing the facial and lingual close to their origin, whichever course be preferred. On the other hand, this operation is a severe one. The jaw, if divided, must be wired, and necrosis of the bone or non-union may follow. For it must be remembered that this wound cannot be an aseptic one, and the opening in the pharynx, especially if this has been made by the cautery, may set up septic infection in spite of drainage.

Possible Aids in the above Operations.

1. *Ligature of External Carotid.*—At first sight this step, which ensures very little bleeding, a clear field of operation, and absence of anxiety as to blood entering the larynx, seems one of universal application. But again, the fact that the wound may become septic renders this step one of much risk. With the pharynx opened in the neck, or a laryngotomy or tracheotomy performed, and the tube of necessity retained, septic softening and ulceration about the ligature may occur with fatal secondary hæmorrhage. Thus Mr. Watson Cheyne lost a patient twenty-five days after an extensive operation for epithelioma of one tonsil (*Objects and Limits of Operations for Cancer*, p. 59). He states that Polaillon, who has tied the external carotid in most of his

cases, has lost several from this cause. Mr. Cheyne is inclined, therefore, only to make use of ligature of the external carotid when the operation is performed in two stages*—viz., removal of the enlarged glands and ligature of the external carotid first, and, about a week later, removal of the growth in the throat.

Preferable to ligature of the external carotid will be the precaution of placing a temporary loop around the common carotid (*q.v.*), and tying the facial and lingual arteries, as they are met with, as close as possible to the parent trunk, so as to shut off the tonsillar branches.

2. *Question of a Preliminary Laryngotomy or Tracheotomy.*—The objections to this step are obvious. It introduces another and necessarily septic wound; it is the means of colder air being introduced; it interferes with coughing and emptying the upper air-passages, an interference already brought about by the wound in the pharynx. On the other hand, this course has manifest advantages which are thus put by Mr. Watson Cheyne (*ibid.*, p. 71): "Where an attempt is made to remove the tumour without division of the jaw, or without ligature of the external carotid, and where the mass fills up the throat, and more especially where it runs down towards the entrance of the larynx and on to the tongue, the necessary manipulations cannot be carried out without interfering with the breathing, and exciting so much effort on the part of the patient that there is a very great risk of septic discharge and blood being drawn into the lungs; and besides, it is very necessary in these operations, in order to ensure that the disease *is* removed as thoroughly as possible, that there should be no haste in their performance, and that the surgeon should be able to see exactly what he is doing. Some prefer to do the tracheotomy three or four days before the major operation, but I fail to see the advantage of this; on the contrary, it must be remembered that after three or four days the discharge from the tracheotomy wound has become more or less septic, and consequently in introducing a big tube, such as Hahn's, some of the pus may be pushed before it into the trachea. . . . Preliminary tracheotomy is by no means an absolute safeguard against septic pneumonia, and I should be inclined to try and do without it where the disease is high up, or where it is behind the tonsillar region, and where the base of the tongue or the neighbourhood of the glottis are not interfered with. Where the base of the tongue is interfered with, the patient does not swallow nearly so readily as where this is not the case, and consequently discharges are apt to accumulate about the orifice of the larynx, and so get down the trachea. Hence, in these cases, I think that it is well not only to perform preliminary tracheotomy, but also to go on with Hahn's tubes for some days after the

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* In a case in which Mr. W. Cheyne adopted this plan, a week intervening betwee the two operations, "there was no more bleeding from the deeper parts than if t external carotid had just been tied" (*ibid.*, p. 67). Mr. W. Cheyne only advises th the operation be performed in two stages in cases where the patients are weakly, a the primary and glandular disease both extensive, and perhaps, also, where ligatur the external carotid appears to be desirable. He points out a serious objection to method of operating—viz., that after removing the glands, open lymphatic vessels left which may contain or convey cancerous material to the newly-made wound, thus infect it before the second operation.

operation, till in fact the patient has, to some extent at any rate, regained the power of easy swallowing."

3. *Division of the Lower Jaw, or Removal of the Ascending Ramus.*—The objections to this step have been given at p. 473. On the other hand, in Mr. Watson Cheyne's words (*loc. supra cit.*, p. 80), "There are great advantages to be gained by division of the jaw, and in some cases it is absolutely necessary. When the jaw is divided in front of the masseter and the two parts pulled aside, especially after division of the posterior belly of the digastric and the stylo-hyoid muscles, and with a skin incision running from the angle of the mouth to the upper part of the oblique incision in the anterior triangle, the whole region of the tonsil and side of the pharynx is completely exposed to view, and can be dealt with as precisely as if one were operating on a cutaneous surface; and if this is done there is, of course, no necessity for ligature of the external carotid, the bleeding points being easily secured. Where the disease involves the periosteum over the jaw, necessitating removal of a portion of it or of the ascending ramus, the view obtained is still more perfect. As regards the removal of the ascending ramus of the jaw, if the angle is also taken away, the functional result is bad: the jaw being pulled over to that side, and the lower teeth no longer meeting the upper, consequently the patient cannot masticate solid food. Mickulicz has overcome this difficulty to some extent by dividing the ramus above the angle, and he states that in his cases the functional result is excellent, while a good view is obtained, and there is no trouble from closure of the jaws as the result of contraction of the wound."

In cases of extensive disease—*e.g.*, where, in addition to the tonsil, the wall of the pharynx and the base of the tongue are involved—it will be needful to divide or resect the jaw, and so too in operations for recurrent disease, where it is thought well to attempt these. When the surgeon is in doubt, he will begin by making an incision along the sterno-mastoid, and one running obliquely from this up to the jaw just in front of the anterior border of the masseter. By the flaps thus raised the anterior triangle can be freely opened up and the glands removed. When the posterior belly of the digastric and the stylo-hyoid are divided, the jaw and larynx can be pulled forward to a very considerable degree, and a marked increase in the space obtained (W. Cheyne). If by this means and by slitting the cheek sufficient access to the disease be not obtained, the incision through the cheek is prolonged down to the anterior border of the masseter, and the jaw divided.

After-treatment.—The same precautions as after removal of the tongue must be taken for keeping clean the wound in the mouth (p. 467). Where, in addition, there is a wound in the neck, this is plugged at the time of the operation with iodoform or cyanide gauze. This is removed at the end of twenty-four or thirty-six hours, and after this no plugging should be employed, the wound being kept clean by the patient very frequently washing it out by one of the fluids given at p. 468 (and there is nothing better and less irritating and poisonous than strong Condy's fluid), and letting it run out by the drainage-tube or tubes which project from the wound in the pharynx through the deepest part of the wound to the most dependent part of that in the neck. This will necessitate frequent changing of the salicylic wool or other dressing round the neck. It will probably be well to retain one drainage-tube *in situ* for a week or ten days. It should be taken out and boiled before re-insertion, daily. Feeding by aid of a soft tube will be needful for some time, perhaps as long as two or three weeks, where removal of the parts around the tonsil, the wall of the pharynx, or the base of the tongue has been extensive. The patient's feeding himself should be forbidden as long as any attempt at this causes choking or coughing, owing to the danger of fluids entering the air-passages. As after removal of the tongue, the patient should sit up and be got out of bed as soon as possible.

CHAPTER XII.

OPERATIONS ON THE AIR-PASSAGES IN THE NECK.

THYROTOMY—LARYNGOTOMY—TRACHEOTOMY—REMOVAL OF FOREIGN BODIES IN THE BRONCHI—EXCISION OF THE LARYNX.

THYROTOMY.

Indications.

(i.) Growths which cannot be removed through the mouth, but which do not require severer operations on the larynx itself. The following are the chief conditions which must decide the removal of laryngeal growths by an operation from the mouth or by thyrotomy: (*a*) The amount of special laryngeal skill possessed by the operator. (*b*) The nature of the growth, whether multiple or no, if pedunculated, if recurrent after attempts at removal from the mouth. (*c*) The extent of the growth. (*d*) The irritability of the larynx. The amount of self-control of the patient. Any tendency to asphyxia.

(ii.) Large rough foreign bodies*—*e.g.*, bits of bone, &c.

In a case brought before the Clinical Society (*Trans.*, vol. xvii. p. 214) by Dr. Taylor and Mr. Golding Bird a bit of mutton-bone was impacted between the vocal cords, where it could be seen with the laryngoscope. It was removed by Mr. Golding Bird by a vertical incision with its centre over the cricoid cartilage, the crico-thyroid membrane being incised horizontally. A tracheal dilator being introduced, the bone was seen at once, and extracted with Toynbee's ear-forceps. The large size of the fragment, its apparently firm position, the fact that the broad surface, and not the edge, presented, together with its position just at the crico-thyroid membrane, led to the external operation being made use of.

Operation.—A preliminary laryngotomy (p. 479), or a high tracheotomy, according to the amount of room required, having been performed, the incision is prolonged upwards, and the skin and fasciæ over the centre of the thyroid cartilage are carefully divided. All hæmorrhage is then arrested, and the cartilage opened along its centre with scrupulous exactness, the thyro-hyoid and crico-thyroid membranes being also divided if needful. The halves being now held widely open, the foreign body is picked out or the papillomata are removed.

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* Mr. Holmes (*Med.-Chir. Trans.*, 1882) has drawn attention to the fact that large substances may be impacted in the ventricle or between the alæ of the thyroid cartilage without causing any symptoms of immediate urgency. As they are liable to give rise to spreading inflammation of the mucous membrane, they should be removed as soon as possible.

Where thyrotomy is performed for papillomata it will be well to remember the following points: If much hæmorrhage is expected, as in the case of large or recurrent growths, it would be well to plug the air-passage below, by the side of and around the tube which has been inserted, by putting the tube into a collar of boiled drainage-tube or sterilised gauze of sufficient thickness. The division of the thyroid cartilage should be effected from without inwards, a stout knife, bone-forceps, or even a saw being sometimes needed in adults. As soon as the upper part is divided, the surgeon should examine if he have sufficient room without further division; and if it be really needful to cut down lower, the meeting of the cords must be treated with the utmost delicacy, and, if the parts have to be opened out, as little tension and stretching as possible should be thrown upon this spot.*

The removal of papillomata is often attended with much difficulty owing to their friability.† They are best snipped away with scissors curved on the flat, and their bases touched with some powerful astringent—*e.g.*, acid nitrate of mercury—or, as I prefer, the actual cautery, owing to their tendency to recurrence (often inveterate).

The object of the operation being accomplished, and all hæmorrhage arrested, the alæ of the thyroid are united by one or two points of silver suture not passed through the entire thickness of the cartilage. A little sterilised iodoform is dusted on, and the usual dressings or a creolin fomentation (warm or cold, according to the feelings of the patient) kept constantly applied.

The tracheotomy-tube must not be removed till all risk of intra-laryngeal œdema, &c., has passed by, though it may be early replaced by one of india-rubber. The after-treatment and complications are much as after tracheotomy (pp. 488, 492). Coughing will be especially harmful now.

Impairment of the voice is not unlikely to occur after thyrotomy, quite apart from any injury inflicted on the cords during the operation, owing to the cicatrix subsequently involving the anterior commissure of the cords. Other possible causes, in spite of aseptic precautions and gentle handling, are chronic laryngitis, the formation of granulations (p. 490), impaired movement of the thyroid, or displacement of the cords. Where the masses of papillomata are large, though the removal has been complete, the patient may never be able to dispense with the tube.

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* Mr. Parker (*Dict. of Surg.*, vol. ii, p. 623), advising that, if it is needful to cut the anterior commissure of the cords, the two alæ of the thyroid should not be quite severed, points out that in children, the parts being elastic, retraction will accomplish much, but that in old people, or where the growth is large or extensive, not only all the cartilage and the thyro-hyoid membrane must be divided, but that, to secure still more room, horizontal incisions may be needed through the crico-thyroid and the thyro-hyoid membranes, close to the borders of the cartilages.

† Mr. Parker (*loc. supra cit.*) found in one case much difficulty in seizing the growths, owing to the reflex excitability set up, notwithstanding deep narcosis. He thinks that the use of cocaine will here be a material aid. I have found this hint of much practical value in one case.

Treatment of Laryngeal Papillomata by Tracheotomy alone.

The results of thyrotomy for papillomata are so unfavourable both as regards recurrence,* much impairment of voice, and stenosis, and the endo-laryngeal operation and intubation are alike so ineffective, that it has been proposed to resort to tracheotomy alone.

Dr. G. Hunter Mackenzie was the first to bring this step forward (*Edin. Med. Journ.*, Nov. 1884; *Lancet*, April 6, 1889; and *Brit. Med. Journ.*, Sept. 12, 1896, p. 609), showing that the papillomata tended slowly to atrophy when the larynx was put at rest and freed from the irritation incidental to coughing, &c. The length of time during which the cannula† requires to be worn varies much. In Dr. G. H. Mackenzie's three cases it remained in the trachea twelve, six, and seven months respectively.

Dr. Railton, of Manchester, published (*Brit. Med. Journ.*, Feb. 19, 1898, p. 489) two cases illustrating the value of this treatment. In one child the cannula was worn for three years and nine months, and in the other for twenty-five months, before it was finally removed.‡

In these cases the condition of the voice and the breathing is examined into from time to time by taking out the cannula and closing the opening, but the instrument is not finally withdrawn until every trace of stridor and hoarseness has disappeared.

George A. Wright, of Manchester, whose experience at the Children's Hospital has been very large, gives (Ashby and Wright's *Diseases of Children*, fourth ed. p. 350) an interesting case in proof of this warning.

In a child of 5, tracheotomy had been performed for laryngeal papillomata. The tube had been removed, at first for short intervals, and later altogether. The child died suddenly in an urgent attack of dyspnœa. The fact that, in addition to a mass of papillomata on the vocal cords and at the site of the tracheotomy wound, there was an early stage of tuberculosis of the bronchial glands and lungs, suggests, as is pointed out, the possibility of a hospital infection with tuberculosis through the tube.

The same authority is of opinion that "in papillomata of the larynx it is, on the whole, best to perform tracheotomy, leaving resort to thyrotomy for cases in which long use of the tube is unsuccessful."

LARYNGOTOMY.

In this operation the tube is inserted through an opening in the crico-thyroid membrane. It is called for, in preference to tracheotomy, on account of the greater facility with which it is performed, in cases of emergency, and in those where a tube can quickly be dispensed with.[*] Finally, it is inapplicable before adolescence.

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* In addition to this very marked tendency to recurrence there is the risk that the trachea may have to be opened to prevent suffocation after the child has appeared to be convalescent.

† An india-rubber tube is to be used whenever possible, and granulations springing up at the wound are to be destroyed at regular intervals.

‡ Possibly a cure may be secured in a shorter time by a combination of the methods; removing the papillomata carefully at once by a thyrotomy, and at the same time giving rest to the larynx by keeping a tube in the trachea.

Indications.

1. Sudden impaction of large foreign bodies threatening suffocation, as when a bolus of food carelessly swallowed lodges in the upper aperture of the larynx.[†]

2. Before operations likely to be attended with much bleeding—*e.g.*, those on the tongue, jaws, tonsils, &c.—in order that the fauces may be plugged with a sponge.

3. When spasm of the larynx is threatening very suddenly, as in tetanus or aortic aneurysm. As a rule, tracheotomy,[‡] when there is time to perform it, is preferred in these spasmodic affections, and it will be considered later (p. 501).

Operation. An anæsthetic will be given in those cases in which laryngotomy precedes another operation; in other cases the patient's head must be kept steady. In either instance the head will be thrown back as far as possible, while the neck rests on a firm support. The precise position of the thyroid and cricoid cartilages is then distinctly made out, the notch in the upper part of the former and the ring of the latter being almost always recognisable. The larynx being then steadied (not squeezed) with the left fingers and thumb, and the skin at the same time drawn moderately tense, an incision about an inch and a half long is made, exactly in the middle line, over the lower part of the thyroid, the crico-thyroid interval, and the cricoid.

If relief be urgently called for, the knife should pass down to the crico-thyroid membrane at once, and the left index having identified this, the membrane is opened by cutting horizontally just above the cricoid cartilage.

If the surgeon have more leisure, he may reach the crico-thyroid membrane more gradually, feeling his way, using retractors, and perhaps identifying the interval between the sterno-hyoids. The only advantage of this is that all hæmorrhage can be arrested before opening the air-tube. This is sometimes severe, and has been fatal by dyspnœa.

In inserting the tube, care must be taken that both the crico-thyroid membrane and the subjacent mucous membrane are punctured and that the tube is really within the cavity of the larynx, not pushed down into the cellular tissue outside it. The cannula, which should be shorter than those used for tracheotomy, of uniform bore throughout, and oval in section, is then secured with tapes.

TRACHEOTOMY (Figs. 203 and 204).

This operation will be carefully considered under the first of the following indications, and more briefly in its relation to the other ones.

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[*] Owing to the proximity of the tube to the cords, this operation is not suited to cases in which an instrument has to be worn for any time.

[†] In these very urgent cases the operation may be performed with, *faute de mieux*, a sharp penknife and a toothpick quill.

[‡] Sir J. E. Erichsen, in his *Surgery*, gives many other conditions for which a high tracheotomy is usually reserved.

Indications.

1. Croup and diphtheria.
2. Syphilitic and tubercular ulceration, in order to give rest to the crippled part (p. 500).
3. Malignant disease of the larynx (p. 500).
4. Papillomata of the larynx (p. 479).
5. Acute laryngitis (p. 501).
6. Certain spasmodic affections, *e.g.*, tetanus, or aneurysm of the thoracic aorta (p. 501).
7. Foreign bodies in the air-passages: the removal of those which may lodge in the bronchi are treated separately (p. 504).

TRACHEOTOMY,[*] WITH ESPECIAL REFERENCE TO CASES OF MEMBRANOUS LARYNGITIS.

General points all bearing upon a successful result:[†]—(A) The age of the patient. (B) Right time of operating and wise selection of cases. (C) Skilful operation. (D) Painstaking and appropriate after-treatment.

A. **Age.**—Recovery before the age of two is very rare. Some of the youngest cases recorded are Mr. Bell's at seven months, and Mr. Cooper Forster's at eleven months.[‡] On the other hand, M. Trousseau considers that the frequency with which tracheotomy is unsuccessful in adults with membranous laryngitis is due to the fact that the large size of the larynx retards asphyxia till the bronchi are invaded. Again, the older children are, the more strength have they, and the better is the hope of recovery; whereas younger children fail more quickly, with their poorer vitality, and the greater facility with which their narrow air-passages are choked up with membrane, &c.

Average of Recoveries after Tracheotomy for Membranous Laryngitis.[§]—In pre-antitoxin days one case in three or four was a good average. Prof. Buchanan[‖] cured nineteen out of fifty, or one in every 2⅔ cases. Nowadays, especially in institutions where the rule holds good to inject 1000 or 1500 units of antitoxin serum in every case of laryngitis where there is a suspicion of diphtheria, and to inject it early in the course of the case, the percentage of recoveries has much increased owing to the effect the antitoxin has in loosening membrane and in preventing extension. One of the chief living authorities on diphtheria, Dr E. W. Goodall, basing his calculations on a large body of statistics, is of opinion that, as a rule, in the pre-antitoxin days under 30 per cent. (perhaps 26 or 28 per cent.) of cases recovered after tracheotomy. At the present day the proportion of recoveries is about 63 per cent. (*Brit. Med. Journ.*, Jan. 28, 1899, p. 199).

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[*] To speak accurately, the operation in children is usually a laryngo-tracheotomy (footnote, p. 484).

[†] If a little amplified, the conditions chiefly affecting success would run somewhat thus:—1. How far has the operator picked his cases? 2. What proportion were diphtheritic? 3. How many were very young? 4. Was the operation an early or a late one? 5. Was the operator experienced? Was the after-treatment skilled?

[‡] M. Bazeau (*Gaz. des Hôp.*, 1867, p. 397) mentions successful cases of tracheotomy in infants of ten and fifteen months. The very youngest cases with which I am acquainted are one in which Mr. Croft operated successfully in an infant aged six months, with erysipelatous œdema of the neck and chest, and another, still younger, which is quoted in the *Med. Times and Gaz.*, 1880, vol. ii. p. 593.

Turning to the results of foreign surgeons, Dr. Lindner (*Deut. Zeitsch. f. Chir.*, Bd. xvii. Heft 6) states that after the second year there was a marked improvement. In this year the recoveries amounted to 12 per cent., in the third year they rose to 55 per cent. Dr. Passavant, of Frankfort-on-Maine (*Annals of Surgery*, vol. i. p. 582) gives 67 cases of cure out of 229, or about 1 in 4.

[‖] *Trans. Intern. Med. Congress*, 1881, vol. iv. p. 208.

B. **Right Time for Operating,* and Wise Selection of Cases.**—The nature of the dyspnœa is very various, and on this account the above two points are most important.

The four following conditions of dyspnœa are met with: (i.) Dyspnœa rapid, urgent, and localised to the larynx; much anxiety and restlessness; orthopnœa; stridor, the loudness of which is probably proportionate to the degree of obstruction in the larynx and the patency of the small tubes. In Prof. Buchanan's words, it points to a cavity ready to receive air if it could but get it, and to a passage narrowed either by false membrane or spasm, or both. On inspection of the chest, the extraordinary muscles of respiration are seen to be in action, there is much sucking-in of the intra-costal and epigastric, and, later on, of the supra-sternal and supra-clavicular regions. While this sucking-in is vigorous and well marked, the lungs are probably free. Auscultation and percussion are difficult. If the bases are resonant, and show vesicular murmur, it is of good omen. So, too, if the eyes, though starting, are bright, the face suffused, not livid, the lips of fairly natural colour, the cervical veins not much distended, the extremities not cold and the seat of stasis: in such cases the membrane, if present, is limited to the larynx, and the tendency to death is by laryngeal apnœa. Tracheotomy here is not only justifiable, but imperatively called for, if previous treatment has failed; the prognosis is favourable if the operation is not too long deferred. Hopeful conditions: Sudden onset, previous good health, sub-maxillary glands not enlarged, absence of albuminuria.

(ii.) When the dyspnœa increases more slowly though continuously. The restlessness is less violent, and the respiratory effects are less exaggerated. The sucking-in is much less marked, especially above. The chest seems to be impeded in its movements, puffing or heaving out *en masse*, and with difficulty; on auscultation and percussion, instead of vesicular murmur, or conducted hoarse laryngeal rhonchus, and normal bases, there will be found sibilant râles, small crepitation, and deficient resonance. These point to the exudation being no longer localised to the larynx, but more probably invading the finer bronchial tubes and air-vesicles, the former being swollen and infiltrated with membrane, the latter clogged with viscid mucus. The tint of the face is now pale or leaden. The operation is here much less likely to be successful, from the extension of the membrane, and the condition of the lung and of the right heart. Other unfavourable conditions: Onset with much asthenia, albuminuria, and enlarged sub-maxillary glands.

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* Those surgeons who recommend an early operation (and I am of that number) rely especially on the existence of much sucking-in and of undoubted dyspnœa. With regard to the first, Dr. Passavant (*loc. supra cit.*, p. 153) holds that tracheotomy, if deferred, allows prolonged dyspnœa to bring about, simultaneously with retraction of the epigastrium, &c., an action on the lung surfaces analogous to that of a cupping-glass upon the skin—viz., hyperæmia, stasis, hypersecretion of mucus, splenisation, and atelectasis. With regard to dyspnœa, Dr. Ranke, of Munich, lays great stress upon an early operation. "If a child with pharyngeal diphtheria has become hoarse, and shows laryngeal stridor and difficulty in breathing, which has already led to ever so short an attack of real dyspnœa, that child ought to be operated upon at once." Another practical point bearing upon the right time for operation is the fact that at night-time children often get worse. If, then, a case is advancing, and parents cannot towards the day's close make up their minds to sanction an operation, they should be warned that the patient's condition may call for an operation which will be of necessity hurried, and performed under much less favourable circumstances as to light, &c.

(iii. and iv.) Dyspnœa, intermittent or paroxysmal. In the former case it is due probably to collections of viscid mucus or membrane in the larynx and trachea. Good power of expectoration is here very important. Paroxysmal dyspnœa means spasm. This, very common in all laryngeal dyspnœa, is especially so in children. The danger of this is obvious, and the question of tracheotomy will have to be decided according to whether the spasms are increasing, and by the distance of the medical man from his patient.

Three Chief Dangers of Deferring the Operation too long.

(1) Œdema of the lungs.* Owing to the deficient entrance of air, reflex contraction of the pulmonary arterioles takes place, leading to distension of the main trunk, the right heart, and systemic veins. The bronchial veins being also engorged, serous exudation takes place into the finer tubes and vesicles at the bases, and respiration is thus further impeded.

(2) Exhaustion of the heart. Children if they repair quickly are exhausted quickly also.†

(3) Thrombosis of the pulmonary artery. Owing to the stagnation in front, the blood current moves more and more slowly, and this obstruction by thrombi is not remediable by operation. The signs of this condition are increasing dyspnœa, very feeble pulse, and combined pallor and lividity.

Recommendation of the Operation to the Friends.—(*a*) In reply to questions as to the chance of cure, the surgeon will answer, with caution, that the operation conduces to cure by removing the most urgent danger by giving relief to the lungs, and thus also improving the strength by sleep and quiet. (*β*) He will be able to say that if death occur after tracheotomy it will be by exhaustion, not by apnœa most distressing to witnesses as well as to the patient.

C. Points to be noted as to the Operation.

Question of Anæsthetic.—A little‡ chloroform is, as a rule, safe and advantageous. It allays spasm and thus improves the breathing. It prevents struggles and promotes sleep afterwards. Any vomiting which follows will probably be beneficial. It is especially useful in recent, vigorous, and restless cases: where the surgeon is very short of assistance, and where, if I may say so, his practical experience of the operation is not large. Under the opposite conditions it is not needed, and it will, of course, not be given where there is any tendency to cyanosis and unconsciousness. When an anæsthetic is given, the operator should be close at hand, with everything ready, in case the dyspnœa increases suddenly.

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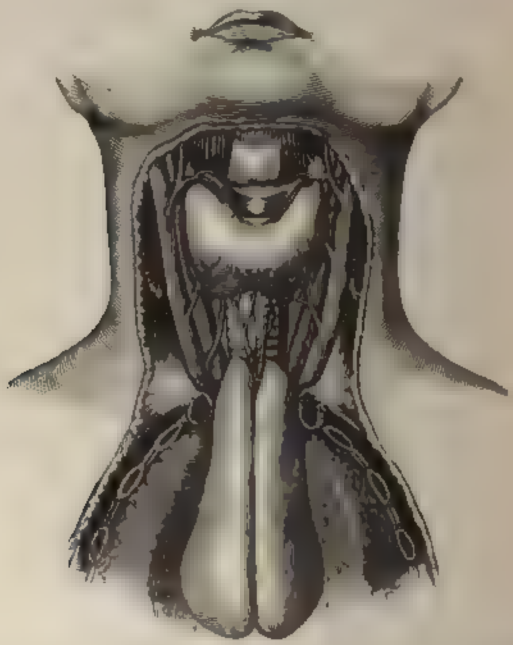
* See also the note, p. 482.

† Prof. Buchanan (*loc. supra cit.*, p. 208) makes an important distinction between sthenic and asthenic cases. In the latter, where the vital powers are rapidly failing, tracheotomy will not save the patient, and will scarcely, if at all, mitigate the suffering.

‡ Just enough to prevent struggling during the operation. After the skin is incised, less is needed.

Site of Operation.—High or low,* *i.e.*, above or below the isthmus. It will be worth while just to consider here the parts met with in the middle line, (A) above and (B) below the thyroid isthmus. (A) Skin, superficial fascia, branches of transverse cervical and infra-mandibular (seventh) nerves, lymphatics, cutaneous arteries, anterior jugular veins—which with their transverse branches are smaller here,—deep fascia, cellular tissue, superior thyroid vessels, the isthmus, usually over the second and third rings,‡ and tracheal layer of deep fascia. The importance of this last is twofold: if the trachea be insufficiently opened the tube may be passed between the trachea and the fascia overlying it, embarrassing the patient's breathing and the operator alike. If the wound become unhealthy, this layer, continuous below with the peri-

Fig. 203.



Anatomy of the neck in early childhood, to show the relations of the thyroid † and thymus. (Heath.)

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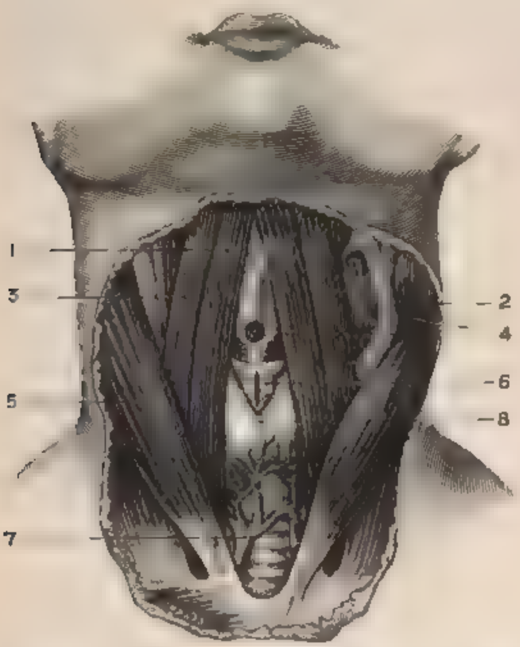
* In children the operation done is a laryngo-tracheotomy, the parts usually divided being the upper two or three tracheal rings, the isthmus of the thyroid, and the cricoid cartilage.

† The isthmus of the thyroid gland is too large.

‡ Mr. Parker (*Tracheotomy*, p. 37) says that in children the isthmus is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring.

ardium, may conduct pus into the mediastina. (B) The surface-tructures are much the same, but the anterior jugular vein and its ransverse branches are much larger. The sterno-thyroids are here* uite close together. The inferior thyroid veins are larger. A thyroidea na may be present, and the innominate artery cross as high as the eventh ring. The trachea is also deeper, smaller, and more mobile, aving no steadying muscles here as higher up. The thymus, too, in oung children might present a difficulty. In addition to the above natomical objections to the low operation, there are three surgical nes, viz.: (1) Pus is now more easily conducted into the mediastina. ?) In the same way, broncho-pneumonia is more probable from a

FIG. 204.



Anatomy of the neck in an adult. 1, Sterno-hyoid. 2, Foreign body in the œsophagus. 3, Omo-hyoid. 4, Crico-thyroid membrane. 5, Sterno-mastoid. 6, Tracheotomy opening in the trachea. 7, Inferior thyroid veins. 8, Isthmus of the thyroid gland. (Heath.)

ound in the trachea lower down. (3) From the proximity of the nest, and its suction-action, the tube is much more pulled into the ound, and, if it has to be worn for a long time, the tube and shield ay part company (Mr. J. Wood, *Lancet*, 1872, vol. i. p. 317).

Operation.—The instruments required are—a small scalpel, with a iangular-pointed handle to act as a blunt dissector, two pairs of pencer-Weils's forceps, dissecting-forceps, steel director, silk or chromic gut ligatures, one or two wire sutures, pilot, and tube.* They should be spread out ready to hand, as, in an instant, moving the child or beginning the anæsthetic may cause most urgent dyspnœa. The question of the anæsthetic has already been alluded to (p. 483). The child's neck and head, at first raised and relaxed,† are stretched over a sandbag or a large bottle wrapped up in a towel, while the hands are secured in the jack-towel which firmly encircles the body. Three assistants at least are required—one to support the head and give the anæsthetic, another to sponge, and the third to prevent any struggling and to hold a light if needed. It is almost superfluous to add that the light should be the best possible; a laryngeal mirror may be of much use in illuminating the bottom of the wound. The surgeon‡ with his left thumb and forefinger steadies the trachea, and makes it a little prominent as well, without any compression; he then incises the soft parts in the middle line from about the centre of the cricoid§ downwards for about two inches, cutting well through the fat, often abundant here, and exposing the interval between the sterno-hyoids; he incises this interval, and, if he has reason to fear hæmorrhage, with the point of a steel director‖ placed in the upper part of the wound, he slits down the remaining soft parts in the middle line till he can distinctly feel or, with the aid of retractors, see the tracheal rings.* The point of the knife is often required here to incise surely the tracheal fascia. Until the tube is distinctly exposed the left forefinger and thumb must not be removed from their steadying position on either side. With the blade of the knife held upwards, the middle line of the front of the trachea is then punctured, stabwise, and two or three rings divided. The sufficiency of the opening is known by a free and noisy rush of air, accompanied often by the expulsion of membrane, which should be sponged away at once. On the other hand, an inadequate opening will be indicated by the hissing only of air through the slit-like opening, without any free rush and with no escape of membrane or relief of the dyspnœa. In this latter case the first opening must be found by the finger-nail and carefully enlarged.† The cannula is then inserted on a pilot, and secured with tapes *in situ*. Some prefer to use a hook to steady the trachea, and a pair of dressing-forceps to dilate the opening; these are more likely to be helpful in a "low" operation, or where a pilot is not used to insert the cannula. If it be desired to try and remove any membrane,‡ the cannula should not be inserted at once, but the opening dilated with dressing-forceps, or with Mr. Golding Bird's or Mr. Parker's dilator. When inserted, the cannula must lie in the middle line, otherwise there will be troublesome irritation of the trachea and plugging of the cannula.

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* Above, the sterno-hyoids are almost in contact in the middle line, with only an terval of about one-eighth of an inch—a strong argument in favour of keeping in e middle line exactly (Parker).

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* The best tracheotomy-tubes are those of Mr. Durham, Mr. Bryant, and Mr. Parker. If the first are chosen, they must be of reliable manufacture. The ball-and-socket of Mr. Bryant's tubes allows of free play. Mr. Parker (*loc. supra cit.*, p. 84) argues strongly in favour of angular tubes. He shows that the usual quarter-inch tubes impinge with their lower extremity on the anterior wall of the trachea, thus tending to produce ulceration and grave risks (p. 493). Mr. Parker, I think, entirely proves his point. I have used his tubes, but find the absence of a pilot troublesome in dealing with little children. Whatever tube is chosen, it should be as large and as short as possible; it should be of the same size throughout, without tapering; the inner tube should project a little beyond the outer one; while the whole tube should fit snugly, standing out as little as possible in the neck. As to the size of the tubes needful, Mr. Parker recommends a series running from No. 18 to No. 30, French gauge, the most useful sizes for children being Nos. 18, 20, 22, 24, 26, and 28 for the outside tube. On this matter of the size of the tube and its relation to the aperture of the glottis and size of the air-tube, the reader should consult Mr. Holmes (*Dis. of Children*, p. 324), Mr. Howse (*Guy's Hosp. Rep.*, 1875, p. 495), and Mr. Marsh (*St. Barthol. Hosp. Rep.*, vol. iii.).

† Whenever an anæsthetic is being given in cases of dyspnœa, the patients, whatever the age, should be allowed to choose their own position at first, and any movements or alterations in the position of the head and neck, preparatory to the commencement of the operation, should be carefully made.

‡ He first, as soon as the head and neck are in position, marks the chief spots in the middle line—viz., centre of the chin and manubrium, and (when they can be felt) the hyoid bone and the thyroid and cricoid cartilages, especially the last.

§ This cartilage is often incised—a point to be, however, avoided. The parts are so small in a child that a tube put in by incising the cricoid is likely to irritate the larynx. Of this the cricoid is the narrowest and a very rigid part. Only the smallest cannulæ can be used here.

‖ Mr. Whitehead (*Lancet*, April 30, 1887), having found that the sharp point of a director will tear open the thin-walled veins here, uses a raspatory after the skin incision. With this he separates the sterno-hyoids, splits the fascia running from the hyoid to the thyroid isthmus, and then, pushing this split fascia on either side with the raspatory, pulls down the isthmus and exposes the trachea, the whole operation being thus rendered easy and bloodless.

Chief Difficulties.—(1) Insufficient skin-incision giving no room for the deeper work.§ (2) Not keeping to the middle line; the abundant fat, and the indistinctness of landmarks—*e.g.*, a flat thyroid in a little child—aiding this mistake. (3) Not steadying the trachea. This omission leads to missing the tube altogether. Cutting to one side of it, or cutting into it laterally, instead of centrally, and insufficiently. (4) Hæmorrhage, the chief bugbear of the operation, varies extremely. Generally it is not great. Any artery which springs should of course be tied at once or caught in Spencer-Wells's forceps, and a vein of any size which lies in the way should be caught between two of these forceps before it is divided. Venous hæmorrhage, as a rule, stops as soon as the trachea is opened and respiration established. A sufficient median skin-incision aids the meeting of hæmorrhage. With regard to the isthmus of the thyroid, this may usually be neglected by the surgeon;

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* Dr. Buchanan considers the following a golden rule: "Never plunge the knife into the trachea till the white rings are clearly seen in the bottom of the wound." In cases of real urgency the surgeon must be satisfied with touch and not with sight.

† If the opening be to one side, as well as too small, a fresh and adequate one should be made in the middle line.

‡ Mr. Parker, one of the chief authorities on this subject, strongly advises that all membrane as well as mucus be got rid of, on account of its impediment to respiration, its infectiousness, and the patient's inability to get rid of it himself by coughing after tracheotomy. On this account Mr. Parker recommends gently twirling about a feather (the shorter and finer pheasant-tail feathers are the best) soaked in a solution of sodium carbonate, and passed several times, not only down into the trachea, but up into the glottis. Mr. Parker condemns attempts to suck out membrane by putting the lips directly to the wound, as of no service to the patient, and as possibly very disastrous to the operator. The aspirator he recommends is alluded to at p. 488.

§ As in a colotomy, or any other deep incision, the wound should not be funnel-shaped.

if felt by the finger to be large, it may be depressed.* If encountered in older subjects, or if large in children, it may be compressed by two pairs of Spencer-Wells's forceps before division, or ligatured on either side by passing an aneurysm-needle beneath it. If, as rarely happens, the venous bleeding is very free, and the patient's condition from dyspnœa critical, the trachea must be felt for and opened before the hæmorrhage is arrested. The urgency of the case must here come before the amount of the bleeding. In these cases the moment the tube is opened the patient must be turned well over on to his side. Entrance of blood, to any amount, into the lungs must be avoided as not altogether harmless; it will add to the dyspnœa now, and, later on, may set up broncho-pneumonia. (5) Insertion of cannula. If the trachea has not been steadied, and the rings not clearly made out by sight or touch, the opening will very likely be made inadequate or to one side. Another difficulty may arise here from the tracheal fascia not having been sufficiently cut, or from the tube being pushed down between this fascia and the trachea, this, of course, only further embarrassing the breathing. Lastly, though the tracheal rings are cut, the swollen and inflamed mucous membrane may not have been sufficiently divided, or a false membrane may have, in the same way, been carried before the knife. (6) Little or no relief after insertion of the cannula. Though this may have been well and truly done, it is not followed by the relief which has been expected. This may be due (*a*) to the tube being passed between the trachea and some membrane which plugs it; (*b*) to the trachea and bronchi being blocked with membrane, &c.; (*c*) to the child, owing to the operation being performed late, being practically asphyxiated before the completion of the operation. The indications now are to pass a long narrow feather down the tube, to remove the tube, and to clear out the trachea, while artificial respiration is vigorously performed and kept up, the opening into the trachea being kept patent by dressing-forceps or by one of the dilators above mentioned (p. 487). If feathers or brushes fail to reach and remove the membrane, trial may be made of aspiration. The best means of effecting this is by Mr. Parker's tracheal aspirator, which consists of a small glass cylinder, three or four inches long, to one extremity of which the end of a silk catheter is attached, and to the other an india-rubber tube ending in a mouthpiece (*loc. supra cit.*, Fig. 12, p. 98). It can be taken to pieces to facilitate cleaning. Before use a little cotton-wool is packed into the cylinder to prevent any dangerous membrane reaching the operator's mouth. Direct suction should never be performed in membranous laryngitis; in other cases where blood alone is the cause of the dyspnœa, it may of course be thus removed.

D. After-treatment.

This subject, neglected in most books, is often too little looked to in practice. The question of the most suitable atmosphere for the patient will first arise. By most a tent (readily improvised by converting a cot into a four-poster, by fastening on four vertical pieces of wood at the corners, joining these by four horizontal pieces, and throwing a sheet over all) is recommended, and one side of the cot being left uncovered, team is conducted thither by one of the different forms of croup-kettles. While fully aware of the need of moisture when the atmosphere is dry, when the membrane tends to crust and become fixed, I am of opinion that the above unvarying rule of cot-tenting and use of steam is disadvantageous. The weakly condition of children with membranous laryngitis, and all that they have gone through, must be remembered. Believing that such seclusion and so little admission of air tend to increase the asthenia, and any tendency to sepsis, I much prefer to be content to keep off draughts by a screen, which allows of the escape of vitiated air above, using steam, if needful, according to the size of the room, fireplace, &c., and according to the kind of expectoration,* whether easily brought up by cough or feathers, or viscid, quickly drying, and causing whistling breathing. If the temperature can be otherwise kept up to 60° or 65°, I much prefer to use a thin flat sponge, often wrung out of a warm solution of boracic acid. The inner tube must be frequently removed and cleansed, every hour or two at first. If the secretions dry on and cling to it, they are best removed by the soda solution mentioned below. At varying intervals between the removals of the tube, any membrane, &c., which is blocking it, appearing for a moment at its mouth and then sucked back, must be got rid of by inserting narrow pheasant feathers, and twisting them round before removing them. If the exudation is slight, moist, and easily brought up by a cough or feather, sponging and brushing out the trachea are not called for, but they should be made use of when there is much flapping, clicking, or whistling of the breathing; and if this is harsh, dry, or noisy, instead of moist and noiseless, two of the best solutions are sodæ bicarb. gr. v.-xx. to aq. ℥j., or a saturated one of borax with soda. These may be applied by a hand or steam spray over the cannula for five or ten minutes at a time, at intervals varying according to the relief which is given, or applied with a laryngeal brush, feather, or a bit of sponge twisted securely into a loop of wire. When any of these are used, the risk of excoriation and bleeding, and the fact that only the trachea and large bronchi can be cleaned, must be borne in mind; and with regard to manipulations for cleansing the trachea, and removing the inner tube, it is most important to remember that the caretaking may be overdone, and a weakly child still further exhausted by meddlesome interference. This point requires special attention from the surgeon in the case of some of the nurses of the present day, who seem to wish to transfer the entire charge of the patient into their own hands.

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* In children this may certainly be ignored. If the knife is used to open cleanly and sufficiently the deep fascia, and then a round-pointed steel director to clear the way down to the trachea, the operation will be almost bloodless.

There is often much difficulty in getting sufficient food taken. The pain in swallowing, the impairment of the act owing to the presence of the tube, &c., and thus the facility with which liquids may reach the lungs, the need of waking up the child frequently to give it food, are all facts to be duly remembered. It will usually be better to pass a

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* G. A. Wright (*Dis. of Child.*, p. 164) gives a useful hint from Cocks (*Arch. Pædiat.*, Jan. 1884) that sudden obstruction of the tube is most often due to inspissated mucus, not membrane; this thick mucus is secreted usually about twenty-four hours after the operation, and after three or four days the discharge becomes thinner and more puriform.

Jaques' catheter (No. 4 or 6) by the nose, and then to feed the patient, at regular intervals, with definite amounts. Care must be taken to see, by the absence of irritation, that the tube is not in the larynx, and, if the above soft tubes are used, that they do not coil up at the back of the tongue.

The removal of the tube next requires consideration. It should be dispensed with at the earliest possible opportunity, either altogether, or replaced by an india-rubber tube between the fourth and ninth days. Quite apart from the danger, which is inseparable from a metallic tube,* of irritation and ulceration of the trachea, there is this object in getting rid of the tube as soon as possible, that the longer the child is allowed to breathe through the tube the more is the act of breathing through the natural passages allowed to be, as it were, forgotten, with the result that, on the tube being removed, asphyxia is threatened.

Conditions which Impede the Removal of the Tube.—(1) Prolonged formation of membrane. The longest possible period for this is probably about ten days. Patience and support are the main indications in the treatment here. (2) The larynx is crippled like any other inflamed part. (3) The air-tube is closed by granulations, usually above the cannula. More common than these is obstinate swelling of the mucous membrane. Here the tube must be removed, and astringents and caustics carefully applied from below, with the aid of an anæsthetic if necessary. (4) Closure of larynx by deep ulceration cicatrising after detachment of membrane. In such a case, with the aid of anæsthetics, the larynx must be opened up by probes of increasing size and laminaria tents introduced from below, and later on by the use of Macewen's tubes (p. 491). (5) Paralysis of the dilating crico-arytenoidei postici, or spasmodic action of the closing ones, arytenoidei or crico-arytenoidei laterales, from fear, excitement, or during effort.† (6) The commonest cause of inability to dispense with the tube is probably due to the rapidity with which the larynx falls into abeyance when a child is allowed to breathe through a tracheal cannula, the patient at this age being not intelligent enough to understand the importance of dispensing with the tube, and perhaps too young to care to talk, or, if older, not realising the need of again using its voice while all its wants are supplied. With the above condition are coupled a nervous dread of having the tube removed, and paroxysms of temper and struggling which rapidly produce embarrassed breathing. Any organic mischief, such as adhesions in the larynx, is I think, extremely rare, and granulations above or below the tube are more often talked of and given as a reason for inability to dispense with the tube than really seen.

But while real organic mischief is rare and the usual cause is due to conditions which would seem to be only temporary, it is well known that, in some cases, getting a little child to dispense with the tube is a most baffling and prolonged affair. The following points are worthy of attention:—Early attempts to remove the cannula, whether metal or india-rubber. A reliable nurse. Ability on the part of the surgeon so to arrange his time as to be himself frequently present at first, and, in the intervals, to be represented by an assistant who will not replace the tube before it is absolutely necessary to do so, and who can dilate the opening with a pair of dressing-forceps and perform artificial respiration if these steps are required. Shortening the india-rubber tube, till eventually little more than the shield is worn, the child being comforted by the apparent presence of the tube. Encouraging the child to make use of his larynx by breathing through the tube and expiring through the larynx while the tube is closed. Patiently persevering efforts to get a child to talk, or, in the case of a younger one, to use his larynx by blowing out a spirit-lamp or using a penny trumpet.[*]

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* Mr. Parker points out (*loc. supra cit.*) that black patches seen on the outer tube when removed may indicate ulceration of the trachea, and show the need of changing the tube.

† In a case in which I had performed tracheotomy, and was watching the child for the first few hours after the tube had been dispensed with, most urgent symptoms came on during the slight straining which accompanied an action of the bowels, the patient falling off the nightstool on to the floor apparently lifeless. Artificial respiration restored the child, and the case did well.

All this time every attempt should be made to improve the general health: wise feeding (too frequent or too large meals provoke dyspnœa), attention to the bowels, such tonics as Easton's syrup, proper clothing, cold or tepid sponging followed by friction, change of scene and air in every possible way, especially at the seaside.

In a large majority of cases the above treatment, aided by patience, tact, and time, which allows of development of the air-passages, will suffice. In a few the attempts at removing the tube will still fail. Where this is so, and, in fact, in any case where the use of the tube seems likely to be protracted, the larynx should be dilated—a step which is brought about by simple means, as the larynx is usually merely functionless from disuse, not blocked up, or the glottis closed—by a tube through which the child is made to breathe.

In a recent case the simplest way of effecting this is, after chloroform has been given, to remove the tracheotomy-tube, dilate the wound if needful, and pass upwards from it a drainage-tube or catheter with a double silk web; the upper end of this is drawn out of the mouth (with the aid of a gag if needful), and tied to the lower end which projects through the wound. The tracheotomy-tube is then replaced for a day or two, and on the withdrawal of the tube from the larynx it can usually be dispensed with altogether. Another very simple and efficient means is thus given by G. A. Wright (*loc. supra cit.*, p. 165): "A flexible probe should be passed up through the glottis from below, and a piece of silk carrying a small sponge be attached to it; the probe should then be drawn out through the mouth, and the sponge carried through the larynx sweeps it out, breaks down any adhesions, and clears away mucus or any granulations."

In cases of longer standing the above simple treatment may not be sufficient, and here the use of Macewen's tubes passed through the larynx[†] and into the trachea below the wound should be made use of. Chloroform having been given, one of the above tubes—they resemble stout gum-elastic catheters with terminal carefully bevelled openings—is passed from the tracheal opening[*] up through the larynx into the mouth. Having hooked this end out of the mouth,[†] the surgeon now passes the other end down the trachea beyond the wound, a step sometimes accompanied with difficulty. The object of the surgeon should be to place this lower end of the tube only just below the tracheal opening, so that air is drawn in from the end projecting through the mouth into the trachea, without leaving any needless length of the tube here or in one bronchus for fear of setting up irritation or secretion. To prevent the child pulling out the tube, the hands should be secured for the first few hours, and to prevent the tube being bitten it is well to pass a piece of drainage-tube[‡] over the first few inches. This end is then secured with tapes around the head. The tube may be left in from twelve to eighteen hours, according to the amount of secretion and the facility with which the tube is blocked. While this treatment is being carried out it is well to isolate the child in a separate room, as the breathing through the tube is very noisy, being often accompanied by very loud bubbling sounds, and the aspect of the child while this necessary dilating of the larynx is going on is one of apparently great distress. When it is evident that the tube is clogged it must be withdrawn and cleansed, and, a little anæsthetic having been given, again inserted. At any time, if needed, the cannula must be re-inserted and artificial respiration performed. It will readily be understood that during this time the presence of the surgeon, and reliable assistants who will not lose their heads, and nurses with much tact and temper, are pre-eminently required. Even when laryngeal breathing is restored and the tube has been dispensed with, the child must be carefully watched, especially at night. If natural breathing fails, it is better, whenever there is time, to replace the Macewen's tube in the trachea rather than re-insert the tracheotomy-tube into the old wound, a mode of relief which is too likely to be resorted to on account of its facility but one which tends to keep up the sinus-like nature of the wound in the trachea, and brings back that most pernicious tendency of the child to prefer and confide in this mode of breathing.

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[*] I may advise my readers to consult a most practical paper by Dr. Steavenson (*St. Barth. Hosp. Rep.*, 1881).

[†] See a paper by Mr. Bilton Pollard (*Lancet*, 1887) on this subject.

Complications of the After-treatment.

(*a*) *Hæmorrhage.* This is not common; if immediate, it is due to some vessel having been left unsecured. Later on, it may be brought about by ulceration of the trachea set up by the pressure of the cannula;[§] through separation of the false membrane by sloughing; a velvety and swollen condition of the mucous membrane; or by prominent granulations. The treatment is clearly preventive—to dispense with a tube, especially a metal one, as soon as possible, and from the first to use one of appropriate length and curve (footnote, p. 486).

(*b*) *A Sloughy Condition of the Wound.*—If this is threatening, attention must be paid to the tightness of the tapes, so that the cannula be not needlessly buried in the wound, and to the wearing of a collar of lint behind the shield. The tube must be removed at intervals, or replaced by an india-rubber one, air tending to enter without a tube as soon as the edges of the wound are set and healing. If the wound be not only sloughy, but gangrenous and diphtheritic, in addition to frequent cleansing with a camel's-hair brush, the use of iodoform and hot boracic or zinc chloride lotions, stronger measures, such as the application of pure nitric or carbolic acid, will be called for. The general treatment will not, of course, be neglected in these cases.

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[*] It is more easy to pass the tube this way owing to the facility with which, when passed from above, it finds its way into the œsophagus.

[†] The tube will be found to pass readily behind the soft palate.

[‡] This simple means is much better borne by the child than the gag. I owe its suggestion, some years ago, to Dr. Arthur E. Poolman.

[§] Some undoubted cases of ulceration into the innominate after low tracheotomies in children are on record—*e.g.*, *Path. Soc. Trans.*, vol. xi. p. 20.

(c) *Emphysema.**—This is usually the result of a faulty operation. The incision into the trachea is either wrongly placed—*i.e.*, it is not in the same line with that in the soft parts—or it is too small; perhaps two small ones have been made; very rarely is the emphysema due to too large an incision in the trachea. Or, the incision may have been correctly made, but some fault connected with the tube may produce the emphysema; thus it may have been originally too short, or have been pushed out of the wound by swelling of the soft parts or by coughing. As a rule, this complication is not dangerous unless it be extreme in very young children, or unless it travel deeply; under these circumstances scarification must be made use of, if possible.

(d) *Ulceration of the Trachea.*—This is usually due to the pressure of a cannula faulty in length or curve, much more rarely to separation of membrane or sloughs. There are no definitely characteristic signs of this complication; the following point to it: Streaks of blood expectorated a day or two after the operation, and perhaps discolouration of the lower end of the tube. This accident is especially likely to occur in cases of diphtheria, as the vitality of the tissues is here much lowered. The tube should be left out if possible, or an india-rubber one substituted, worn as short as possible, and cut obliquely so that the end does not impinge upon the anterior wall of the trachea. If it is necessary to dispense with all tubes, attempts may be made to keep the edges of the tracheal wound stitched to that in the soft parts for a few hours, or Mr. Golding Bird's dilator may be worn.

(e) *Suppuration in Mediastina.*—This is a rare complication. When it does occur it is liable to be very rapid. It results from a descending cellulitis from the wound. The only treatment is prevention by a well-performed operation and by attention to the wound.

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* On this subject the reader should consult the laborious, accurate, and researchful papers of Dr. Champneys, in vols. lxv., lxvii., and lxviii. of the *Med.-Chir. Trans.*, and his work on *Artificial Respiration.* The following are amongst the practical conclusions with which his pages abound:—(1) Emphysema of the anterior mediastinum, often associated with pneumothorax, occurs in a certain number of tracheotomies. (2) The conditions favouring this are, division of the deep cervical fascia, obstruction to the air-passages, and inspiratory efforts. (3) The incision in the deep cervical fascia downwards should not be longer than needful; it should on no account be raised from the trachea, especially during inspiratory efforts. (4) The frequency of emphysema probably depends much on the skill of the operator, especially in inserting the tube. (5) The dangerous period during tracheotomy is the interval between the division of the deep cervical fascia and the efficient introduction of the tube. (6) If artificial respiration is necessary, the tissues should be kept in apposition with the trachea, and any manipulations performed without jerks.

Other complications which are not surgical may, of course, be present—viz., Extension of the exudation downwards. General infection. Paralysis. Albuminuria. Broncho-pneumonia, a very frequent one, known by a rise of temperature with frequent respiration and dyspnœa, dulness on percussion, bronchial breathing, with bubbling and crepitant râles.

INTUBATION OF THE LARYNX AS A SUBSTITUTE FOR TRACHEOTOMY IN MEMBRANOUS LARYNGITIS OR STENOSIS OF THE LARYNX.

This is one of those new methods of treating old diseases which have not taken very firm root in this country. Attention was first called to this subject by Prof. Macewen (*Brit. Med. Journ.*, July 24 and 31, 1880). The tubes he used have been alluded to at p. 491. It was, later on, more prominently brought forward in America.*

The **Advantages** claimed. Many of them are self-evident, and the chief of them, the easy and rapid introduction of a tube, has been substantiated of recent years, when the favourable conditions of special skill and experience are granted.

(1) The consent of the friends will be more quickly obtained than in the case of tracheotomy. (2) Intubation requires no anæsthetic. (3) The tubes are easily and quickly introduced, and thus the operation is much more rapidly performed. (4) There is no severe or difficult operation as in tracheotomy. (5) The inspired air is drawn warm and moist through the natural passages; thus the depressing effects of a steam-tent are avoided (Codd, *loc. supra cit.*) (6) The tubes are self-cleansing. In Dr. Codd's words, "The cough is much more explosive and efficient, retention of membrane and mucus is avoided, and therefore there is less tendency to pneumonia." (7) There is no open wound requiring careful treatment, and there is not the same difficulty in getting rid of the tube. (8) The after-treatment is therefore much less prolonged. This advantage is not to be expected invariably. In the words of Dr. F. Wright, of New Haven, U.S.A. (*Pediatrics*, Feb. 15, 1899): "It occasionally happens that after the original trouble for which intubation was done has disappeared, it is impossible to remove the tube from the larynx without dyspnœa returning, necessitating the return of the tube. Such a condition is termed 'retained tube.' O'Dwyer, the authority upon all matters pertaining to intubation, in a paper read before the American Pediatric Association in May 1897, said that 'the cause of persistent stenosis following intubation in laryngeal diphtheria can be summed up in a single word—"traumatism." Paralysis of the vocal cords may possibly furnish an occasional exception to this rule.' The reason of the traumatism may be a tube that does not fit, one that is imperfect in its construction, or injury to the tissues by

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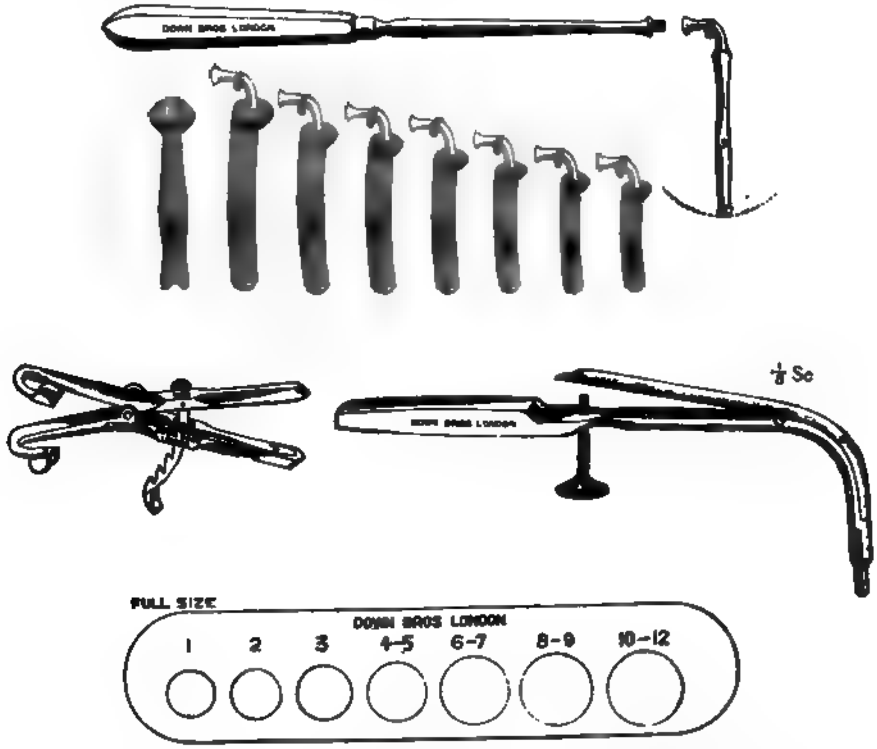
* Especially by the late Dr. O'Dwyer, whose first paper appeared in the *New York Med. Journ.*, Aug. 1885. Amongst more recent papers are: O'Dwyer, *Arch. of Pediat.*, 1897, xiv. p. 481; Hillis, *Trans. New York Med. Assoc.*, 1896, xiii. p. [illegible]; L. [illegible], *Jahrb. f. Kinderheilk.*, 1897, Bd. xxiv. S. 257; Simpson, *Laryngoscope*, 1898, [illegible] p. 313; Ledbetter, *ibid.*, p. 229; L. Fischer, *N.Y. Med. Rec.*, 1898, vol. liii. p. 800; Willard, *Edin. Med. Journ.*, 1898, p. 607.

unskilled operators. Undoubtedly most of the cases of retained tube are due to the tube being too large, notwithstanding the size designed for the age has been used. This condition has most frequently happened when the 3 to 4 size has been used. If the pressure is great enough to seriously interfere with the circulation, even if it does not cause ulcer, there will be an œdema of the surrounding tissues. The tube being withdrawn, the pressure is suddenly removed, and the submucous tissue becomes infiltrated, and, being surrounded with cartilage, can swell in but one direction, thus obstructing respiration by narrowing the lumen of the larynx. Sometimes the head of the tube, by making undue pressure upon the parts on which it rests, causes an abrasion from which granulations spring, and, as the tube is removed, these drop down into the chink of the glottis and obstruct respiration."* (9) There is no need of specially skilled nurses.

FIG. 205.



Dr. Codd's set of intubation instruments for children, consisting of seven of O'Dwyer's latest model vulcanite intubation tubes, fitted with Codd's obturators, introducer, and extractor; Denhard's gag, self-retaining; and gauge-plate.

Disadvantages, Difficulties, and Dangers.—(1) In Dr. Codd's words, "The epiglottis may be very turgid and the parts generally œdematous, and the point of the tube, though entering the upper part of the larynx, may fail to get through the glottis or even to get as far as it. This can be got over by thrusting the left index-finger firmly down to the glottis. I have nearly always found this to succeed, and it is not a bad plan to follow systematically. The inexperienced sometimes enter the ventricles of the larynx if they diverge from the middle line. American laryngologists describe subglottic stenosis as a frequent obstruction to intubation." (2) In introducing the tube, membrane may be dislodged into the trachea, causing fatal dyspnœa unless tracheotomy be performed at once. Dr. Codd adds: "I have never had any cases dying from this cause. In the cases that have died or stopped breathing during the operation, I have failed to enter the larynx, and got into the œsophagus; and owing to the suddenness of the symptoms I am inclined to attribute them to syncope, though they might probably be due to the completion of the stenosis by the tube lodging in the œsophagus and pressing on the larynx from the back." (3) There may be great difficulty in getting children to take sufficient food, as swallowing is for the first few days much embarrassed. The importance of getting sufficient food down has already been alluded to (p. 489). (4) Parts of the liquids taken find their way into the air-passages. Dr. Codd considers the latter "a theoretic objection." The difficulty in feeding can be met by the Casselbury method: "The child is placed on the nurse's lap, the head being down, and fed with a spoon, so that it swallows uphill." (5) The tube may be coughed out. In such cases, if the medical man is absent, death may occur in a few minutes. (6) The tubes are liable to become plugged with membrane. Recently, special patterns of wider tubes have been recommended for use in cases where there is much loose membrane or discharge. Dr. Codd recommends "short cylinders. The largest possible size should be used and wedged into the larynx, and retained only a few hours at the most." It will be obvious to all how easily ulceration and subsequent stenosis might follow in a case thus treated, where the practitioner was prevented from visiting the patient at the time required. (7) Thus the tube, if retained for several days, as is often needful, may cause ulceration of the larynx or trachea; a fatal case of this kind is recorded by Dr. F. W. Carr (*Lancet*, 1891, vol. i. p. 713). The tube here used was "somewhat large," a smaller one having been coughed out.

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* According to Dr. F. Wright, necrosis of the cricoid has been known to follow intubation, though rarely. The above lesions are to be met by trying tubes differently shaped, both as to head and body, so as to relieve the points of pressure.

Any one wishing to contrast fairly and practically the two operations of tracheotomy and intubation should consult a paper by Dr. R. W. Lovett, of Boston (*Med. News*, Aug. 27, 1892). The writer shows that between 1864 and the end of 1887 tracheotomy was performed for membranous laryngitis 327 times at the City Hospital: of these 95 recovered, making a recovery percentage of 29·05; 10 died during or soon after the operation, but only 4 of these from hæmorrhage. The first intubation was performed Dec. 31, 1886, and up till Jan. 1, 1891, the operation was performed 392 times. Of the 392 cases, 312 died and 80 recovered, giving a recovery percentage of 20·41. Intubation was complicated with many accidents. In 21 cases, as soon as it was attempted, immediate tracheotomy was necessitated by the cessation of breathing; of these only 2 recovered. In 3 death occurred while the tube was being inserted. In 2 the tube was drawn into a bronchus, and death resulted. In 2 the insertion of the tube was followed by convulsions.

In 2 the introducer broke during the operation. Dr. Lovett points out that both operations were performed under most favourable conditions as far as a specially well-equipped hospital and very experienced attendants went. He adds that during the time that intubation was practised, tracheotomy was performed 139 times, with a recovery percentage of 11½, but as these were the most desperate cases in which intubation seemed hopeless, 19 of them being moribund at the time of operation, they are not to be taken into consideration in any way. Dr. Lovett protests against intubation as a tentative measure, to be followed later by tracheotomy if the case does badly. Of these secondary tracheotomies there were 57, with but 5 recoveries. From the above paper of Dr. Lovett, it is clear (i.) that intubation does not compare favourably with tracheotomy, as (*a*) the death-rate of intubation is 9 per cent. higher, and (*b*) accidents are much more common during intubation. It must be remembered here that in each case the operation was performed by peculiarly experienced hands. (ii.) That if tracheotomy only is performed it should be a primary operation.

Dr. Lovett considers that intubation fails in being as successful as tracheotomy for saving life in severe laryngeal diphtheria, for the two following reasons, mainly: (1) The amount of food taken is much more limited in most cases of intubation. To this point I have already alluded at pp. 489 and 496. (2) Intubation does not afford such good drainage to the trachea. After tracheotomy, large quantities of mucus, pus, and diphtheritic membrane are expelled through the tube for several days. After intubation this does not occur. The above material may be swallowed or it may be inhaled, but it is not often expectorated. This material is highly septic, and its retention must be harmful.

Dr. Lovett concludes: "In general I should be glad to advocate the performance of tracheotomy instead of intubation in most cases of severe laryngeal diphtheria, except in the case of children under two years, when intubation is to be performed." One of our chief English authorities, G. A. Wright, of Manchester, gives the following opinion (Ashby and Wright, *Surgical Diseases of Children*, p. 347):—"We have had some experience of the method in various forms of laryngeal obstruction, and have not been led to take a very favourable view of its suitability for cases of diphtheria where false membrane in any quantity is present. Of 11 cases of intubation under our care, in 3 success followed, in 3 tracheotomy was subsequently successfully performed, and in 4 instances the children died in spite of tracheotomy. The operation appears best adapted for cases where there is little or no false membrane—*i.e.*, certain types of acute laryngitis, the less severe forms of diphtheria where tracheotomy is for any reason undesirable, and for use in cases where mechanical obstruction remains after tracheotomy, or results from cicatricial contraction in the larynx. It is certainly unsuitable for bronchitic or pneumonic patients."

While Dr. Codd in his candid and helpful paper ("Intubation of the Larynx," *Birmingham Med. Rev.*, Aug. and Sept. 1898) has no hesitation in declaring that intubation is by far a better operation than tracheotomy—emphatically so in hospitals, and, he believes, also in private practice—his results cannot be said to bear this out. Of 26 cases of intubation for diphtheria, 14 were fatal. All were treated with antitoxin. With regard to these results, which cannot be compared with those given by tracheotomy, combined with serum-treatment, in a large hospital at the present day, it is noteworthy that they are the outcome of the work of an operator who has evidently taken up the subject with much zeal and ability.

I do not recommend my readers to adopt intubation as a substitute for tracheotomy. At children's hospitals, where special skill may be gained, it will be justifiable to employ it, though the experience of Dr. Lovett, given above, is extremely noteworthy. I am well aware that with regard to these the mortality has diminished considerably, especially with the aid of antitoxin. But the fact remains, that the accidents so candidly published by Dr. Lovett are grave and numerous, and the recently published results of Dr. Codd's are not encouraging. If such was the case with intubation "performed under most favourable circumstances, as far as a specially well-equipped hospital and very experienced attendants went" (Lovett), what is likely to be the result if intubation be attempted by those who can have no special experience, called as they are to employ this mode of treatment only occasionally, and then in times of great emergency? I am aware that these last words apply to tracheotomy also, but this, I submit, though a difficult operation, is not one requiring the same special experience and skill. It is only fair to add that the introduction of antitoxin has led to the same improvement in the results of intubation for diphtheria as it has in those of tracheotomy (p. 481).

Dr. T. H. Halsted (*New York Med. Journ.*, vol. lxv. No. 24, 1897) compares intubation before and after the introduction of antitoxin, with the following conclusions:—(1) Laryngeal diphtheria in any epidemic is never mild, but has always had a mortality of from 90 to 95 per cent., reduced by operation to from 72 to 76 per cent. (2) His report shows a mortality, after intubation, without the use of antitoxin, of 76 per cent.; in cases of intubation treated with antitoxin, of 25 per cent.; and in cases of death within twenty-four hours of injection, a mortality of 10 per cent. The reduction of the mortality from 76 to 10 per cent. is to be attributed to antitoxin. (3) Antitoxin should always be injected as early as possible, and, in laryngeal cases, without waiting for the bacteriologist's report. If this be done it will usually prevent extension to the larynx, or, if the larynx be already invaded, an early injection will frequently cure without an operation. No child should be allowed to die of laryngeal stenosis without an operation, preferably intubation; and serum should be injected at once, regardless of the stage of the disease, as most desperate cases often end in recovery.

Dr. F. E. Waxham reports (*Archiv. Pædiat.*, vol. xv. No. 3, 1898) a series of 29 consecutive intubations for diphtheritic laryngitis, with 27 recoveries, all having been treated with antitoxin.

Technique of Intubation.

O'Dwyer's Method.*—To prevent movements of the child, it is wrapped securely in a blanket, and placed in an upright position on the lap of a nurse, the head resting on her left shoulder. The nurse holds the child's upper limbs securely with her hands, and the lower ones with her knees. An assistant standing behind, and to the left of the nurse, holds the head of the child inclined somewhat backwards, perfectly steady, and towards the operator. The latter, seated so as to face the patient, opens the mouth widely with a gag.* He then, while his right hand holds an introducer with a tube of appropriate size † fitted on and threaded, with his left index finger, protected with a finger-stall or a sealed gauze-dressing, hooks up the epiglottis. The position of the glottis being thus localised, the tube is carried along the inner side of the left index, and then downwards and forwards by raising the handle of the introducer, which must be carefully kept in the middle line. When the tube is in place the left index finger gently pushes it down, and. at the same time, the introducer is withdrawn, the handle being gradually depressed. George Wright (*loc. supra cit.*) gives a point of much practical importance here: "Any difficulty in introducing the tube may, we have found, be got over by waiting for an inspiratory effort on the part of the patient, and then slipping in the tube." With his left index the operator then makes sure that the tube is in place, by feeling the posterior wall of the larynx between his finger and the tube. If this is not the case the tube will be found to be in the upper part of the œsophagus; it can be removed by the string, and the operation repeated.‡ Expulsive coughing and a peculiar rattling of mucus which immediately follow the introduction of the tube and the withdrawal of the finger usually denote that the tube is safely *in situ*. The gag is now withdrawn, and the child allowed to breathe quietly for a few minutes. If there be no obstruction to respiration the gag is again inserted, and the left finger-end being placed on the head of the tube, so as to prevent its being displaced, the thread is withdrawn. George Wright (*loc. supra cit.*) is of opinion that "it is much better not to withdraw the thread, so as to facilitate extraction; usually it sets up little or no irritation."

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* Dr. Codd in his paper (*loc. supra cit.*) describes a method of intubation modified from Dr. O'Dwyer's. The chief point is that to prevent syncope the tube is introduced with the child in the recumbent position. As will be seen in his paper, Dr. Codd has also introduced some practical improvements in the instruments used (Fig. 205).

Withdrawal of the Tube.—Two points call for consideration here—(*a*) *The date at which the tube may be dispensed with.* (*β*) *The mode of withdrawal of the tube.*

(*a*) *The date at which the tube may be dispensed with.*—No hard and fast rule can be laid down here. The following data (F. Wright, *loc. supra cit.*) will help in a decision: (1) The earlier antitoxin has been administered, the earlier will the membrane be loosened, and the sooner may the tube be removed. (2) A temperature falling to 99° or lower. (3) A generally satisfactory condition of the child. (4) If, in spite of every care in feeding the child, both in the recumbent (p. 496) and the erect position, food is badly taken, this, *cæteris paribus*, is an indication for removal of the tube. Dr. Codd (*loc. supra cit.*) says on this point, "As a general rule four days suffice to leave the tube in, though re-intubation is often necessary."

(*β*) *The mode of withdrawal of the tube.*—This is somewhat more difficult than intubation. In the latter the operator has the tube under his command; in its withdrawal he has to get command of it (F. Wright) The position of the patient being the same, the surgeon hooks up the epiglottis with his left index, and rests the tip of the finger on the posterior part of the head of the tube. The curved extracting forceps is passed along the palmar aspect of the finger, being kept strictly in the middle line until it reaches the tube just in front of the finger. The handle of the extractor being gently raised, its point, aided by gentle movements of the left index finger, now finds the entrance into the tube and is dropped into it. The right thumb now presses on the spring, separates the blades, and the tube is withdrawn. Previous to introducing the extractor, the amount to which its point can be opened out must, by means of a screw on the under surface of the instrument, be carefully adjusted to the size required for the removal of the tube, otherwise much injury may be inflicted on the soft parts about the upper orifice of the larynx.

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* If this is not self-retaining, it must be entrusted to careful and, if possible, skilled hands.

† The gauge-plate supplied with the tubes (Fig. 205) will tell, approximately, which tube will be suited to the case.

‡ Dr. Codd's advice here is to be remembered: "If you fail to hook up the epiglottis or get the tube into the larynx at the first effort, withdraw the finger, and, after a short interval, re-insert it. Do not make prolonged efforts."

Intubation in Chronic Stenosis.—The tubes for the treatment of this condition are made in vulcanite as well as in metal. Intubation by means of these tubes, if obtainable, will be found preferable to the use of the gum-elastic ones of Macewen in the case of adults. The full account already given above will suffice here also.

OTHER INDICATIONS FOR TRACHEOTOMY.

(i.) **Syphilitic and Tubercular Ulceration.**—Of these, tracheotomy is the more frequently called for in **syphilis**, in which also it is decidedly more useful. The conditions which demand it, *temporarily*, are, œdema of the glottis, setting in on old mischief; fibroid thickening, which may, later, yield to treatment; and, more *permanently*, probably, deep ulceration, necrosis, and cicatricial contraction.

In **tubercular mischief**, tracheotomy rarely gives much relief, dyspnœa being now a rarer misery than cough and difficulty of swallowing, both of which are conditions which may be intensified by the presence of a tube.

(ii.) **Malignant Disease of the Larynx.** Here tracheotomy is often called for. Till statistics of extirpation of the larynx are more complete, the question which of these modes of operative interference has the soundest basis must remain uncertain. One difficulty alone which besets this matter is scarcely to be surmounted, and that is that an increasing number of cases shows that, to be really successful, extirpation of the larynx must be performed early; but how many patients will submit to it at this stage?

In deciding between advising a palliative tracheotomy and extirpation of the larynx the surgeon will be guided by the condition of the disease and that of the patient. The latter operation can alone be justified when the disease is strictly localised. Enlargement of the lymphatic glands, extension of the disease, especially in cases of carcinoma, to the pharynx, back of the tongue, or tonsil, should put this operation aside. Again, the condition of the patient, how far he is exhausted, how far his strength is sufficient for such an operation as extirpation, how far he gains ground after a preliminary tracheotomy, have all to be considered. My readers are also referred to pages 506 to 511.

(iii.) **Acute Laryngitis.**—The rapidity with which this may run a fatal course, especially after exposure to cold in reduced constitutions, is well known. If treatment, including scarification of the arytæno-epiglottidean folds and adjacent parts, fail to relieve the dyspnœa, tracheotomy should be performed at once to meet the increasing exhaustion.

(iv.) **Certain Spasmodic Affections**—*e.g.*, **Thoracic Aneurysm and Tetanus.**—Owing to these diseases destroying life, usually, in other ways, tracheotomy is rarely called for here. Occasionally, however, the laryngeal dyspnœa which they may bring about calls for this operation.

Probably there is no form of dyspnœa more agonising to the patient, or more distressing to the friends, than that which may accompany **thoracic aneurysm.** The surgeon, however, when called upon to perform tracheotomy in one of these terrible cases, must remember that the dyspnœa may be due to direct pressure upon the trachea as well as to pressure or irritation of the laryngeal nerves, that it is in the latter only that operation will give relief, and that the difficulty of distinguishing between the two, though much diminished by the laryngoscope, is not entirely removed.

I would refer my readers on this point to one of Dr. Bristowe's interesting Lumleian Lectures,* and especially to the following passage: "Destruction of the functional activity of one recurrent laryngeal nerve is attended with, of course, paralysis of the corresponding vocal cord (which can be recognised by means of the laryngoscope), with impairment of the musical quality of the voice, and apparently with some difficulty of swallowing, owing to the tendency of food to slip into the trachea, but is certainly not necessarily attended with stridor or dyspnœa; in the second place, compression of the trachea involves stridor and dyspnœa, which is often paroxysmal and is liable to end in sudden death, but does not itself interfere with intonation or phonation, excepting in so far as it may render the voice weak by diminishing the supply of wind to the vocal organ." As the paroxysmal nature of the dyspnœa may thus be met with in cases of pressure on the air-tube below the larynx as well as in laryngeal dyspnœa, the chief points to rely on will be the result of a laryngoscopic examination, and the freedom of the lungs and air-tube from pressure. Dr. F. de H. Hall† thinks that "the absence of respiratory excursions of the larynx points to the chief impediment being below the glottis.

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* *Lancet*, May 18, 1879. Dr. Bristowe goes on to show that the exacerbations of dyspnœa in narrowing of the trachea may be due partly to spasm of the muscular fibres, but mainly to accumulation of mucus below the narrowing, and to the difficulty of dislodging it by coughing.

† *Clin. Soc. Trans.*, vol. xix. p. 82. Quoting from Gerhardt (*Lehrb. d. Ausc.*, Tübingen, 1871), Dr. Hall points out that in a case of aortic aneurysm the following causes for dyspnœa (Dr. Powell, *Reynolds' Syst. of Med.*, vol. v. p. 32) may all be present together: (1) Undoubted paresis of the abductors of the cords. (2) Though the necropsy may "not show any very distinct bulging inwards of the trachea, the aorta and sac being emptied of blood, yet I can readily believe that during life, when these parts were distended with blood, considerable pressure was exerted on the trachea, and that this narrowing led to accumulation of the tough mucus which so bothered the patient." (3) Gairdner (*Clin. Med.*, p. 486) states that paroxysms of dyspnœa, closely resembling those of asthma, may be occasioned by compression of one of the pulmonary plexuses.

With regard to tracheotomy in **tetanus,** the same warning has to be given. In the rarer cases in which tetanus threatens life by asphyxia and not by exhaustion the surgeon, before performing tracheotomy must decide where lies the seat of the asphyxia In the few cases that I have seen in which asphyxia closed life in this disease, the asphyxia was due to spasm of the muscles of respiration, including the muscles of inspiration and those of expiration—*e.g.*, the abdominal muscles also. The fatal spasm thus, usually, not lying in the larynx tracheotomy seems contraindicated, unless it were done with the object of relieving, with the aid of artificial respiration, that congested, gorged condition of the lungs which is due to the continued spasm of the muscles of respiration. And it is to be feared that if these steps were taken, the gentle violence of artificial respiration would, as has happened with tracheotomy itself in this disease, only bring on further and perhaps final and fatal, spasms.

(v.) **Scalds of the Upper Aperture of the Larynx.**—Tracheotomy is here usually deferred until late, and its want of success is well known. This is not, however, an instance of cause and effect the mortality in these cases being rather due to the shock, pain, and inability to take sufficient food. Unless the case is seen late, tracheotomy should not be performed in these cases till a trial has been made of scarification, or rather of acupuncture, by means of a guarded bistoury point, of the mucous membrane of the epiglottis and the glosso-epiglottidean and arytæno-epiglottidean folds, the left forefinger guiding the point of the instrument. In doing this the surgeon must remember the amount of dyspnœa which is already present, and the certainty that this will be increased by the struggles of the child, by the finger coming in contact with the inflamed parts above: at any moment the child must be turned on its side, artificial respiration performed, or tracheotomy at once resorted to

(vi.) **Foreign Bodies in the Air-passages.**—We will suppose a child brought to the surgeon with a history of having swallowed one of the usual foreign bodies. Two questions now call for an answer. (1) Is there a foreign body at all in any part of the air-passages? and (2) If so, where is it? In regard to the first question, it is well to remember that the history is often far from clear, especially in children, and the symptoms by no means so obvious as they are often described to be Thus, the chief aids in distinguishing the entrance of a foreign body from such a disease as membranous laryngitis are the sudden onset and, not unfrequently, the well-marked intermissions. The symptoms characteristic of the entrance of a foreign body into the larynx—viz., the urgent dyspnœa, the cyanosis, the struggling against impending death—may not be got at on account of the youth of the patient, or because no one saw the onset: while if the body has passed from the larynx into the trachea, or into one bronchus, the dyspnœa brassy cough, and alteration in the voice may all have disappeared before the surgeon sees the child, and yet he will be expected to give a definite opinion. Again the body may have been coughed up or perhaps swallowed. Finally, in adults, usually hysterical and egotistical women, who come with a history of cancer, dysphagia, &c., owing to a pin which they aver to be in their throats, the diagnosis will sometimes be far from easy.*

Having settled that a foreign body is really present, the surgeon, unless tracheotomy is urgently called for, tries to decide where the body is lodged. A careful examination should be made in a good light, with a finger in the fauces, the laryngoscope being employed when feasible, any information about the size and nature of the body having been previously obtained.

(*a*) A large or irregular body, such as bolted—*i.e.*, unmasticated—food, or artificial teeth, usually lodges above the upper aperture of the larynx, and causes urgent and often fatal dyspnœa. If, however, the first attack be survived, bodies of considerable size—*e.g.*, a plate with one or two false teeth, or a halfpenny—may lodge near the base of the epiglottis and arytæno-epiglottidean folds for a very considerable time. Such cases should be treated by laryngotomy to meet the urgent dyspnœa, and extraction of the bodies either by the finger, or appropriate forceps, or probangs.

(*β*) A small and light body—*e.g.*, a bead, a pea, or more likely an irregular one, as a bit of nutshell—may stick in the rima or ventricle of the larynx. If the first urgent symptoms pass off without operation,† the position of the body will be pointed to by the shortness of the intermissions between the attacks of spasm, and by the pain and the marked alteration of the voice.

The treatment, here, would be, first, to perform a high tracheotomy (p. 484), and to dislodge the body from below with a female catheter or a bougie of appropriate size, the cricoid cartilage being divided if needful.‡ If the body cannot be dislodged in this way, a partial or complete thyrotomy (p. 477) must be performed.

(*γ*) If the body pass through the larynx it will depend mainly on its outline and weight whether it remain in the trachea or pass into one of the bronchi. Thus, if it be light and smooth—*e.g.*, a cherry-stone—it may frequently shift its position, and then, from time to time, rising into the larynx, cause spasm, and thus attacks of urgent dyspnœa, with paroxysmal cough and temporary aphonia.

In such cases tracheotomy should be performed with a free opening into the air-tube, this being kept open by stout silver-wire ligatures passed through the edges of the wound and tied behind the neck, or a dilator such as Mr. Golding Bird's may be inserted.

(*δ*) If the body be smooth and heavier it will probably fall into one of the bronchi. This subject is dealt with next, separately.

Finally, I would urge the advisability of an early tracheotomy when there is any reason to believe that there is a foreign body in the air-passages, even if no urgent symptoms be present. Dyspnœa may come on suddenly at night, and, if not fatal, may cause the shifting of a foreign body from a favourable to an unfavourable site—*e.g.*, from the upper part of the trachea to a bronchus. If, after deciding that a foreign body is present, the surgeon do not perform tracheotomy before he leaves the patient (a step to be always taken if he lives at a distance), he should arrange for the instruments, &c., being ready at hand for any emergency.

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* I would refer my readers to some instructive remarks by Mr. Lund on the delusive impressions which may arise from the imagined swallowing of false teeth, &c. (*Hunt. Lect.*, 1885, p. 34).

† Occasionally, when the body is in the ventricle, the consequences may be very slight for a long time, especially if it is smooth and soon coated with mucus, and partly encapsuled. Mr. Durham (*Syst. Surg.*, vol. i. p. 760) mentions a case of Desault's, in which a patient, with a cherry-stone in one of the ventricles, refused operation and lived for two years, death then taking place from laryngeal disease.

‡ In adults, attempts at removal with the laryngoscope and laryngeal forceps, aided by a 20 per cent. solution of cocaine, may be successful.

Tracheotomy under Cocaine.—Before leaving the subject of tracheotomy, the above must be referred to, especially in its reference to cases of chronic stenosis of the larynx. While I am not in favour of performing delicate operations under local anæsthesia where a general anæsthetic can be given by skilled hands, it is certain that in some cases the risk of the operation is greatly increased by the use of a general anæsthesia. I refer to cases where a patient, who has been obliged to keep in one position in order to facilitate his breathing, has a sudden attack of urgent dyspnœa when he is placed in the position for tracheotomy. Again, in some cases of marked stenosis, general anæsthesia, by abolishing the voluntary respiratory movements, may render it impossible for sufficient air to be drawn through the narrowed larynx. B. Frankel has called attention (*Berl. Klin. Woch.*, June 6, 1898) to the value of cocaine in such cases. He injects a 20 per cent. solution in two places, or a 10 per cent. in four places. In children, only the 10 per cent. solution should be used. In a few minutes tracheotomy can be performed painlessly. Local anæsthesia is less dreaded by patients than a general one. Frankel has never found that, under cocaine, it has been necessary to complete the operation in a hurry owing to threatening asphyxia. He has thus performed tracheotomy in seventeen adults—in five for laryngeal syphilis, in six for tubercular laryngitis, in four for carcinoma, in one for chronic laryngitis, and in one for stenosis after attempted suicide. In two other cases tracheotomy was performed for acute disease. In four cases chloroform was used, as well as cocaine. After a certain amount of anæsthesia has been induced, cocaine was injected, and the tracheotomy performed during partial narcosis.

FOREIGN BODIES IN THE BRONCHI.

Amongst these may be tracheotomy-tubes,* especially ill-made ones, tubes worn too long, particularly if a low operation has been done

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* Dr. Cohen (*Internat. Encycl. Surg.*, vol. v. p. 665) thus speaks of the frequency with which these bodies have slipped in, when ill made or corroded: "This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasise the point with quite an array of references: Porter, *On the Larynx and Trachea*, p. 144; Gross, *Foreign Bodies in the Air-Passages*, p. 325; Albert, *Arch. f. Clin. Chir.*, Bd. viii. S. 197; Waters, *Brit. Med. Journ.*, vol. i. 1868, p. 141; *Boston Med. and Surg. Journ.*, Feb. 23, 1871; Buck, *Trans. New York Acad. Med.*, 1870; Pick, *Trans. Path. Soc.*, 1870, p. 416; Ogle, *Med. Times and Gaz.*, 1870, vol. ii. p. 531; Holthouse, *Lancet*, 1872, vol. i. p. 113; Ogle and Lee, *Lancet* 1872, vol. i. p. 81; Hulke, *Lancet*, 1876, vol. ii. p. 785; Davy, *Brit. Med. Journ.*, 1876, vol. ii. p. 45; Baron, *Berl. Klin. Woch.*, No. 36, 1876; Thornton, *Tracheotomy*, p. 36; Howse, *Lancet*, April 17, 1877."

p. 485); pebbles; fruit-stones; parts of toy whistles; pieces of utshell; &c. &c.

Site of Lodgment.—It was shown by Mr. Goodall that owing to the eptum being a little to the left, and the right bronchus the larger, the oreign body usually lodges in this.

According to M. Bourdillat's statistics,* out of 156 cases of impaction, 80 were in the rachea, 35 in the larynx, 26 in the right bronchus, and 15 in the left. Out of 21 cases nalysed by Prof. Gross (Durham, *Syst. of Surg.*, vol. i. p. 758), in which death took lace without operation, and without expulsion of the foreign body, in 4 the foreign ubstance was situated in the larynx; in 1 partly in the trachea, partly in the larynx; n 3 in the trachea; in 1 in the right bronchial tube; in 1 in the lung; in 9 in the right leural cavity. Out of 42 cases subjected to operation and general treatment, the xtraneous substance was situated twice positively, and 11 times probably, in the right ronchial tube; 4 times certainly, and 4 times probably, in the left bronchial tube; times in the trachea, and 14 in the larynx. From these statistics it would appear that the trachea, larynx, and right bronchus are the most likely places in which a foreign ody will be arrested.

Evidence of a Foreign Body having lodged in a Bronchus.—Perhaps here may be a history of a foreign body held in the mouth; pain, dull nd heavy, behind the sternum, at about its junction with the second ight costal cartilage;† shortness of breath; cough; expectoration; ore or less diminution of breath sounds over a portion of the chest all;‡ râles; increased breath sounds on the opposite side; and, later n, evidence of inflammation and destruction of lung tissue.

Treatment.—A low tracheotomy (p. 484) should be performed at nce, and with as free an opening as possible. The edges of the incised rachea being held open with sutures of wire (not too fine), inversion nd succussion should be tried, and a feather or probe passed in order o excite cough.

If provided with suitable instruments (see below) the surgeon may t once proceed to attempts at extraction, but it is well to remember the fact pointed out by Mr. Durham (*loc. supra cit.*, pp. 769, 770), that in a large proportion of the cases which have done well, expulsion has not been effected until some time after the operation.* Whenever a fit of coughing brings the body into view, the next inspiration will draw it back again, so that careful watching and prompt use of forceps, &c., will be required.

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* Cohen (*loc. supra cit.*, p. 688). Dr. Cheadle and Sir T. Smith reported (*Lancet*, an. 14, 1888) a case of occlusion of the left bronchus by a metal pencil-cap in a girl ged 9. Urgent dyspnœa followed at once, relieved by the passage of an œsophageal robang, the foreign body being believed to have entered the stomach. There was great ain at the time, and violent cough. By the eleventh day there was evidence of almost omplete collapse of the left lung, this having commenced on the fourth day. There as no dyspnœa, but occasional short cough. The cap was believed to have lodged at he end of the left bronchus. Tracheotomy was performed through the thyroid isthmus, ivided between two ligatures. The trachea was freely opened and its edges sutured o the skin. A long probe detected the cap in the position diagnosed, with the open nd uppermost. It was easily extracted with suitably curved forceps. A good recovery ollowed.

† The division of the trachea is opposite the spine of the third, in some cases the ourth, dorsal vertebra. In front this division is on the level of the junction of the irst with the second bone of the sternum. The root of the spine of the scapula is on a evel with the third intervertebral space. A stethoscope placed here would cover the ronchi, more especially the right (Holden).

‡ "Obstruction of the left bronchus usually produces absence of respiration over the ntire lung of that side; obstruction of the right bronchus usually produces absence of espiration over the lower lobe of that side only, the division of the bronchus taking lace much nearer the bifurcation, and the foreign body rarely lodging above the point f division" (Dr. Cohen, *loc. supra cit.*, p. [illegible]).

If from its shape, or from the interval which has elapsed, the body is too firmly impacted to be expelled by exciting coughing, the following instruments should be resorted to—viz., Gross's flexible German-silver tracheal forceps, long and slender and easily bent into any curve; or Durham's forceps, equally flexible and giving a better grip.

Failing the above, stout silver or copper wire should be bent into the form of a blunt hook, or a long probe fashioned into the same shape.† The above instruments are first used as sounds and searchers, aided by the forefinger, which can be passed as far as the bifurcation of the trachea and the orifice of each primary bronchus, as pointed out by Dr. Sands.‡

The operation should not be too prolonged, especially if the parts are inflamed: when this condition has subsided, spontaneous expulsion will often take place. Annandale§ recommends that this be promoted by the patient's taking a deep inspiration; the surgeon then closes the tracheotomy wound till expiration, thus rendered more violent, follows, and often drives out the body.

EXCISION OF THE LARYNX, PARTIAL AND COMPLETE

(Figs. 206, 207, 208).

The value of these operations is still *sub judice;* much, therefore, of the following will require confirmation.

Indications.

(i.) Sarcoma and carcinoma of the larynx, if intra-laryngeal.

The following questions must be answered when extirpation of the larynx is under consideration: A. *Is the disease malignant?* B. *How far is it advanced?* C. *Is it intra- or extra-laryngeal?* D. *Which is the wiser operation to perform—excision, or a palliative tracheotomy?* To give an answer here, (1) *the results of the operation*, and (2) *the after-condition*

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* Thus, in a case of Dr. Smith's at Halifax (*Lancet*, 1876, vol. ii. p. 148), a boy, aged 8, swallowed a whistle (as thick as a penholder, and about half an inch long) on January 8; it was not expelled till May 7, the child having, for the previous six weeks, had increasing cough and expectoration with progressive emaciation. The boy recovered, and Dr. Smith draws attention to the fact that, owing to the very slight discomfort, it is doubtful if the cause would have been recognised if the impacted body had not produced a whistling sound, and thus demonstrated its presence.

† Mr. Hulke (*Lancet*, 1876, vol. ii. p. 785) used a long piece of German-silver wire, one end of which was formed into a blunt hook about one-eighth of an inch long, and the wire again bent about an inch and a half above this, at an angle roughly estimated as that which the right bronchus and trachea include. The other end was fashioned into a large loop, the plane of which coincided with that of the tracheal end of the wire beyond the angle, and thus allowed it to be guided into the right bronchus.

‡ *Amer. Clin. Lect.*, vol. ii. p. 199; Putnam, New York, 1876. Quoted by Mr. Durham, *loc. supra cit.*, p. 771.

§ *Med. Times and Gaz.*, Feb. 27, 1875.

of the patient, have to be duly weighed. E. *Does the general condition of the patient justify the operation?*

A. *Is the case one of malignant disease?* B. *How far is the disease, if malignant, advanced?*—A well-known case drew attention, a few years ago, to the great difficulty of always diagnosing carcinoma and the progress which it has made. Sir F. Semon has thus strongly drawn attention to this matter (*Trans. Intern. Med. Congress*, 1881, vol. iii. p. 264). In answer to the objection that in the majority of the cases operated on the disease was already in too late a stage, Dr. Semon said: "Who, in a large proportion of these cases, will take upon himself to diagnosticate early, and positively, carcinoma? and who, again, if carcinoma is diagnosticated, will say positively whether it is in an early or more advanced stage?"

It seems to me that we should face this difficulty, which will always lie before us, in the same way as we do elsewhere. Where a patient has suspicious symptoms, especially at a suspicious age—*e.g.*, alteration in the voice, "soreness," pain, cough, hæmorrhage, interference with breathing or swallowing—instead of waiting to see what potassium iodide, &c., will do, we should adopt the same steps which stand us in such good stead in cases of doubtful malignant disease elsewhere, and explore. Where such interests are at stake, there should be no hesitation in advising opening of the thyroid cartilage and examination of the larynx. If the growth is malignant, extirpation, partial or complete, should be proceeded with at once, or a preliminary tracheotomy alone performed at this stage. If the disease is not malignant, it will very likely be the better for local treatment, which can now be effectually applied. If the thyroid cartilage be very carefully divided in the middle line, and no further operation done, we know from our experience, in adopting a similar step for the removal of certain foreign bodies, that no harm will happen to the cords, while the relief to the patient's mind will be enormous. It is only by this early and complete exploration that we can hope to attack the disease in a stage when it can be entirely removed.

As to the appearance of the ulceration, Dr. Grant and Mr. Lennox Browne (*Arch. of Laryng.*, New York, vol. ii. 1881) write: "The floor of a *tuberculous** ulcer is pale and granular, and slightly depressed; the margins fairly well marked, but not deeply excavated; the surrounding parts pale and languid; and there is an appearance of a spreading process of erosion very comparable to that of the nibbling of a small rodent animal. This is due to the confluence of small ulcers produced by the slow incurable inflammation of the mucous and closed follicles of the mucous membrane, and also to the injection of minute tubercles which have worked their way to the surface. Very different from this is the punched-out areolated excavation which is seen in *tertiary syphilis*, and which may be considered suggestive of a bite rather than of the continuous nibbling to which we have likened the tuberculous ulcer. Nor need we insist on the angry, hyperæmic, thickened walls of a *cancerous* ulceration, with its accompanying deformities and other signs, to still further point the laryngoscopic diagnosis."

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* For a good instance of the difficulty in deciding between carcinoma and tubercle of the larynx, see *Brit. Med. Journ.*, 1888, vol. i. p. 609.

C. *Is the disease intra- or extra-laryngeal?**—It has been shown, by Krishaber and Fränkel, that laryngeal carcinoma, the squamous and horny epithelioma especially, is limited to the larynx for a considerable time, and, while limited to the larynx, is slow to infect the glands. Extrinsic carcinomata, on the other hand, affect the glands at an early stage. The sarcomata, while rapid in growth and marked in their power of infiltrating, do not here affect the glands. The opinion has been increasingly held of late that extirpation of the larynx should only be attempted while the disease is limited to that cavity,† and not infiltrating adjacent structures and glands. Several cases have been recorded in which parts of the pharynx have been removed, in others portions of the œsophagus, trachea, and thyroid gland,‡ but the results are, with a few exceptions, far from encouraging, not only because a dangerous operation is rendered still more hazardous, but also because recurrence is usually rapid. Extirpation in extra-laryngeal cases is an operation in which the surgeon may not know where to stop, owing to the extent of the disease. In deciding whether the disease is extra-laryngeal, the surgeon will be helped by observing whether the larynx moves in deglutition, and from side to side,§ whether the glands are involved (*vide supra*), by information gained by the finger passed from the mouth with the aid of cocaine, by the rate of the changes observed with the laryngoscope, and by the character of the growth from the first—*i.e.*, whether horny, flat, and sessile, or dendritic and papillary. Dr. Newman, in his instructive book (*loc. supra cit.*), writes: When the disease is intrinsic, "the prominent symptoms are aphonia and dyspnœa. The lymphatic glands are seldom affected; as a rule, cachexia is not a prominent feature during the earlier stages of the disease, and dysphagia is not a common symptom. In patients suffering from an extrinsic growth, on the other hand—*e.g.*, one creeping in from the pharynx,—aphonia is not usually present at the commencement of the disease, and, indeed, there may be only slight alterations in the voice; while dysphagia is, as a rule, present as soon as the growth has reached any considerable size. Pain in larynx and pharynx, extending round the neck and to the ear of the affected side, is more characteristic of extrinsic than of intrinsic new formations. In the former the glands are also involved at an early period, and cachexia is usually pronounced."

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* In some cases this has only been decided during the operation, as in a case of Mr. Holmes's (*Brit. Med. Journ.*, 1884, vol. ii. p. 809), in which, during the laryngectomy, part of the epithelioma was found to lie outside the larynx, extending upwards. In some cases the carcinoma is extrinsic from the first—*i.e.*, commencing in the pharynx, and involving the larynx by invading the epiglottis or arytæno-epiglottidean folds.

† Dr. Newman, of Glasgow (*Malignant Disease of the Throat and Nose*, p. 107), states that "the prognosis is worst in extrinsic carcinomata, most favourable in intrinsic sarcomata, while the intrinsic carcinomata may be said to occupy an intermediate position." He considers that in cases of extrinsic disease tracheotomy is the only operation permissible.

‡ Thus, Czerny, quoted by Dr. Newman (*loc. cit.*), in a case of lympho-sarcoma which had perforated the thyroid cartilage and involved the neighbouring glands, removed the latter repeatedly. The internal and external carotid, the internal jugular, and the vagus were divided, and the patient died fifteen months after the primary operation. A similar case of Dr. Gerster's is an exceptional one, and it must be remembered—(*a*) that the growth was a sarcoma, (*b*) that the removal of the larynx was partial, and (*c*) that the last report was only carried up to a little more than half a year after the operation.

§ It is noteworthy that the larynx may be movable, and yet the pharynx be implicated, as in a case reported by Surgeon-Major McLeod (*Lancet*, April 26, 1884).

D. *Which is the wiser operation to perform for malignant disease—extirpation of the larynx, or a palliative tracheotomy?* Here we have to consider—(α) *the results of the operation*, (β) *the after-condition of the patient.*

(α) With regard to *the results of the operation*, I may, I think, fairly still take the statistics of Dr. Hahn, of Berlin,* whose wide experience and special opportunities in this branch of surgery are well known. They appear to me to be even more discouraging than the earlier ones, taken from many operators, which he collected previously (*Volkmann's Vorträge*, 1885), and which have been most carefully examined by Mr. Butlin (*Oper. Surg. Mal. Dis.*, p. 192). The cases are divided into three groups—(A) ***Extirpation of Tumours from the Interior of the Larynx;*** (B) ***Unilateral Resection of the Larynx;*** (C) ***Total Extirpation of the Larynx.***

(A) ***Extirpation of Tumours from the Interior of the Larynx.*** —By this is meant opening the larynx ("laryngo-fissure") and scraping it out, with, sometimes, application of the cautery or partial excision of the cartilages. Of the three cases, one died on the eleventh day from heart-failure and pulmonary thrombosis, the patient, an unfavourable one, having urgently requested the operation. In the other two recurrence took place, one unhappy patient hanging himself.

(B) ***Unilateral Resection of the Larynx.***—Of six cases, two died from the operation: of the four recoveries, recurrence took place in one; of the three others, it is stated that one remained free from recurrence for a few months after the operation, and that the two others were discharged cured, one with slight indication of necrosis.†

(C) ***Total Extirpation of the Larynx.***—Of six cases, only one survived the operation and remained free from recurrence, this case being a brilliant triumph, *as far as it goes*—over seven years having elapsed since the operation. While it is only just to Dr. Hahn that I should remind my readers that these are his earliest cases, published with most creditable candour, it is also right that we should remember that these are the results of a man who has had very special opportunities, and who had been working at the subject for eight years. The outlook of the operation appears to me to be extremely gloomy.

Dr. Newman (*Mal. Dis. of Throat and Nose*, 1892, p. 124), quoting from Walssermann, who has collected 219 cases of operation, states that out of 120 cases of complete removal of the larynx, only eight cases are recorded in which the patient remained well over three years after the operation.

Graf, writing in 1897, gave (*Journal of Laryngology*, August) the results of the last thirteen years' work by v. Bergmann. In this time that well-known surgeon had operated on fifty-six cases of malignant disease of the larynx. Twenty-eight were cases of total, nineteen of unilateral laryngectomy; and in nine cases partial excision was performed. Two cases of radical cure are claimed out of the twenty-eight complete laryngectomies, one other patient being alive and well nine months after the operation; out of the nineteen unilateral laryngectomies, and the nine cases of partial excision, in each four patients are claimed to have recovered completely. Rutsch (*Deut. Zeitsch. f. Chir.*, 1899, Bd. i. S. 484) speaks of "recovery as very doubtful." Lendziak (*Die bösartige Geschwülste d. Kehlkopfes*, Wiesbaden, 1897) tabulates from 1873 to 1894, 188 cases of laryngectomy for carcinoma. The results are as follow:—(1) *Recurrence*, 32·45 per cent.; (2) *Relative cure* (less than three years), 6·9 per cent.; (3) *Definite cure* (three years or more), 5·85 per cent.; (4) *Death*, 44·7 per cent. Schmiegelow (*Ann. des Mal. de l'Oreille, du Larynx, &c.*, April 1897) has tabulated fifty cases of total laryngectomy, from 1890 to 1897, and these still later statistics are more encouraging. His table shows (1) *Recurrence*, 20 per cent. (a fall of 12 per cent. from Lendziak's table); (2) *Relative cure*, 48 per cent. (a rise of 14 per cent. from Lendziak's table); (3) *Definite cure*, 10 per cent. (nearly double that of Lendziak's table); (4) *Death*, 22 per cent. (one-half that of Lendziak's table). I have taken the three last statistics from a paper of Prof. Keen's ("The Technique of Laryngectomy," *Ann. of Surg.*, July 1899). Prof. Keen comments on these statistics as follows:—"The mortality, it will be observed, has been halved, and the definite cures doubled, as compared with Lendziak's statistics." I am afraid that this is putting the results of laryngectomy in too favourable a light. Granting that the statistics of Schmiegelow have been correctly tabulated, and the results from them truthfully drawn, there is no getting over the fact that laryngectomy is an operation in which a large number of unsuccessful cases are never made public.* Secondly, as I have repeatedly said, it is fallacious and misleading to claim that cases which have survived the operation for three years are definitely cured. Lastly, no notice is taken in these cases of the fact that, after the removal of a part like the larynx, and after the necessary interference with the parts adjacent to the larynx, the terms "definite cure," "complete recovery," must be used with especial carefulness. It is not here as after the removal of many other malignant growths. In a distinct proportion of cases the patient who recovers merely exchanges one condition of misery for another of discomfort (see footnote, p. 511).

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* A translation of his manuscript will be found in the *Journal for Laryngology and Rhinology*, May 1888. Carcinoma laryngis is the only term used for malignant disease.

† A case, for a time most successful, by this operator, on a well-known English barrister, is recorded by Sir F. Semon, *Clin. Soc. Trans.*, vol. xx. p. 44.

(β) *The after-condition of the patient.* This is a most important matter, and one which should be fully explained to the patient. The amount of comfort will mainly depend upon two things—(1) whether half or the whole of the larynx has been removed; (2) whether much of the skin and soft parts has had to be taken away, or has sloughed.

With regard to the first point, if only half of the larynx has been removed, the patient usually swallows early and easily, and speaks quietly and hoarsely, but with very fair distinctness, and without any need of mechanical aid. Where the whole larynx has been taken away, some such appliance as that of Gussenbauer will be required to enable the patient to make himself understood. In these cases much difficulty is often experienced in keeping open the upper part of the wound for the introduction of the artificial larynx. If, after complete removal, the pharynx has been left untouched, the power of swallowing will be but little impaired. If, however, the surrounding soft parts have had to be widely extirpated, so large a gap will be left that swallowing may be impossible, and it will be necessary to feed the patient with a tube.

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* Taking this country only, the very small number of laryngectomies published by those who have special opportunities, and who avail themselves of these opportunities, carries its own tale.

While, for the present, it must remain uncertain how far the after-condition of the patient will be better than that foretold after the earlier laryngectomies,* there is no doubt that when the soft parts in front of the pharynx have had to be extensively removed, the after-condition is one of great discomfort.†

E. *Does the general condition of the patient justify the operation?*—The age of the patient (not only to be recognised by years), his power of meeting and of recovery after a very severe operation, the presence of any liability to bronchitis, broncho-pneumonia, asthma, his capability of assimilating food, the condition of his viscera—*e.g.*, kidneys and liver—have all to be most carefully considered; in addition to such points as the disease, its rate of growth, the probable duration of any ulceration, whether it is intrinsic or extrinsic.

The *conclusions* to be drawn from the above are, I think—(1) That the operation is justifiable in the sarcomata owing to their smaller liability to infect the glands, and to the younger age of the patients, and therefore their *à priori* better condition; (2) that it should be abandoned in carcinoma, save in intrinsic cases, and the earlier stages, while the growth is, if not distinctly unilateral, certainly limited to the larynx—all points which a thyrotomy (p. 507) will clear up.—and the patient, having had all the risks fairly put before him, decides to undergo the operation. In cases where an early stage is found to be present—*e.g.*, disease unilateral and limited to the cords—it is probable, though more cases are required to decide the matter, that the modified laryngectomy which Mr. Butlin (p. 517) has so strongly recommended and successfully practised will be found sufficient. But these early operations will introduce questions very difficult to answer. (*a*) It has been shown above (p. 507) how very difficult it is for even skilled laryngologists to bind themselves to a decisive answer early in the case, and to all that may come of it. (β) Then it must never be forgotten that removal of the larynx is an operation of great severity, liable to entail a condition of shock (especially in patients well on in life) quite out of proportion to the size of the part removed. (γ) Furthermore, this operation, especially its severer forms, apart from the question of recurrence, has special risks of its own—*e.g.*, septic cellulitis and broncho-pneumonia,—and thus an early operation may, if fatal, shorten a life materially. (δ) Statistics are in such a case especially unreliable. Thus, while all the successful operations are probably published, many of these have been insufficiently followed up, while, on the other hand, it is certain that many unsuccessful cases have never been brought forward.

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* Thus, the late Sir M. Mackenzie, at the International Medical Congress, 1881 (*Trans.*, p. 263), stated that "the condition of a patient after extirpation of the larynx is usually one of great misery." Dr. Cohen, of Philadelphia, holding the same view, drew attention to the importance of distinguishing between "recovery" and mere "survival" after the operation.

† A good illustration of this condition and an idea of its results are given by Dr. Cohen from Lange (Fig. 1095, *Inter. Encycl. of Surg.*, vol. v. p. 776). He also points out that too early attempts to use an artificial larynx only cause hæmorrhage, while an apparatus which is adjustable at first, is often rendered useless by further cicatrisation.

A palliative tracheotomy, as soon as dyspnœa sets in, will be the wisest course in all cases unsuited to excision—*e.g.*, advanced or extrinsic ones—where this operation is refused, and in cases where the surgeon is in doubt. As the average duration of life in epithelioma here is from two to two and a half years, the time still remaining after tracheotomy may be from one to one and a half year. The fact must be in no way kept back or made light of, that the closing months will be a time of much misery.* It will be wise to prepare the friends for this at the time when the question of operative interference, with all its risks and uncertainty, is discussed.

(ii.) A few cases may arise in which there is no malignant disease, but the laryngeal cavity is destroyed, and is a constant source of discomfort and danger.

Thus, in Dr. P. Heron Watson's case,† a gentleman aged 36, palliative tracheotomy had been performed to relieve the ulceration of tertiary syphilis. The larynx healed, but the puckering gave rise to a state of things by which some portion of all fluid nutriment and saliva made its way into the trachea and occasioned fits of spasmodic cough. Feeding by the tube did not prevent the saliva from passing down, and, in almost every instance, on its withdrawal some fluid regurgitated, and some part of it passed into the trachea, &c. The patient rallied from the operation for removal of the larynx, but died some weeks afterwards from pneumonia.

Both in this case and one in which Rubio, of Madrid, removed the larynx for necrosis of the cartilages in a man aged 41, with a fatal result on the fifth day, there was great debility before the operation.

With regard to this group of cases, Dr. Foulis remarked: "When the breathing and voice are impeded, and the parts are no longer capable of distension by dilatation, it appears to me that the diseased larynx may be properly removed and replaced by an artificial one."

(iii.) It is just possible that excision of the larynx may, in the future, be performed as part of an operation for removal of a thyroid gland the site of malignant disease. In these cases, it is well known that removal of the thyroid gland is often fatal, from interference with the recurrent laryngeal, injury to which is often unavoidable. It has been suggested‡ that, in these cases, if it will facilitate extirpation of the malignant disease, or if there is reason to think that the above-named nerve has been injured, the larynx should be removed; this not only giving more room for ealing with the original disease, but also for removing a fertile source f dyspnœa and spasm. But, considering the age and general condition f these patients, it is very doubtful if this suggestion will bear fruit.

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* In a few cases, as in one which Mr. H. Morris brought before the Clinical Society (*Trans.*. vol. xx.; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), removal of the larynx may be called for after a palliative tracheotomy has been done; but, owing to the downward extension of the growth, the tracheotomy-tube becomes a source of continual irritation and distress, though absolutely necessary for respiration, and the suffocative cough and dyspnœa cannot be relieved by other means. The case is alluded to again at p. 520. The patient, a man of 59, sank on the eighth day, from exhaustion.

† Quoted by Dr. Foulis, *Trans. Intern. Med. Congr.*. 1881, vol. iii. p. 251.

‡ Dr. Foulis (*loc. supra cit.*. p. 258) quotes briefly a case of Dr. Bircher's, in which a scirrhous thyroid had been excised; six months later, recurrence took place, and the larynx was excised with part of the gullet. Death supervened in ten days from pneumonia and gangrene of the lung. Prof. Casselli (*Intern. Med. Congr.*, 1881, vol. iii. p. 262) stated that he had performed partial excision of the larynx in the case of an enormous myxo-fibro-chondroma of the hyoid and larynx, the patient, who was much exhausted, dying in three days.

I would say that I have described here, and have mentioned at p. 516, several operations, because the surgeon's aim in attacking ancer here and elsewhere should be twofold. I have alluded at p. 507 o the need of early exploration and of entire removal. To ensure this he surgeon should not feel tied to perform any set or "classical" operation, but, being thoroughly acquainted with these, should do hat which each case requires.

Operation.

Preliminary Tracheotomy.—If this step be taken it should be carried out a week, at least, before any extensive operation for excision. The advantages are that: (1) The patient gets used to breathing through an artificial apparatus. (2) The easier breathing will improve his general health. (3) The lungs, being less engorged after thus receiving air freely, will be less likely to become the seat of broncho-pneumonia. (4) When tracheotomy has been performed beforehand, less time will be taken up by the operation, and no blood will enter from this source. (5) The trachea will have become adherent to the skin, and thus tends less to fall away when the larynx is severed from it, so preventing diffusion of discharges, possibly septic, later on.

With regard to the site of the tracheotomy, it should be low rather than high, for, if done high up, (1) it may be too near the seat of the disease, and (2), a more important point, if a high operation be performed, the lower end of the excision wound will come into parts infiltrated and altered, and thus difficult to distinguish at a very critical stage of the operation.*

A low tracheotomy, seven or ten days before the laryngectomy, is always to be performed in cases where the breathing and lungs require relief. In other cases operators have dispensed with tracheotomy altogether. On this point Prof. Keen (*loc. supra cit.*) writes: "In the case which is the basis of this paper† I did a tracheotomy at the time of operation, but removed the tube at the termination of the laryngectomy, immediately closed the wound in the trachea, and obtained absolutely primary union. In any future case I am strongly of opinion that it will be better to omit tracheotomy entirely. As I shall show, it is not, in my opinion, needful, and by omitting it we should eliminate one cause of septic pneumonia." And again, later on: "A further improvement can be made in the technique, viz., the omission of any—even a temporary

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* On this account Gussenbauer prefers a high tracheotomy with horizontal severance of the trachea as the initial step in laryngectomy, owing to the fact that after a preliminary tracheotomy the tissues become so infiltrated and matted that they are less readily recognised, and also complicate the detachment of the soft parts and make hæmorrhage more serious. On this point Mr. Butlin's argument, that in patients exhausted by long-continued dyspnœa there can be no question that it is essential to success that tracheotomy should be performed some time previous to the operation, will carry great weight with most surgeons.

† The patient was aged 39. The growth was removed down to the cartilage by a thyrotomy in May 1898. In September a recurrence was noticed to have taken place, and in October a complete laryngectomy was performed. The patient recovered rapidly, and was well in May 1899.

—tracheotomy. In my next case, after dissecting the soft parts from the larynx and upper trachea back to the œsophagus on both sides, I shall place the patient in the Trendelenberg position, and deepen the narcosis to a slight extent. I shall then divide the trachea transversely, and by three sutures, one in the middle line and one on each side, I shall quickly attach the tracheal stump to the skin. Then I shall introduce the ordinary tracheotomy-tube into the open end of the trachea, instead of through a tracheotomy wound, and continue the anæsthetic through the tube. In order not to embarrass the operator, the flange of the tracheotomy-tube should only project at the sides, as the usual wide upper border of the flange would interfere with access to the parts at the beginning of removal of the larynx."

The preliminary preparation of the patient as regards the general condition, power of assimilating food, &c., should be of the most careful kind. Prof. Keen (*loc. supra cit.*) draws attention to the need of securing at least partial disinfection of the mouth, nose, teeth, &c. The anæsthetic (the A.C.E. mixture or chloroform being the best) is given as long as possible by the mouth, and later on, when the trachea is severed, through the tracheotomy-tube by tubing attached to an inner tube which fits exactly—this plan keeping the surgeon and the administrator out of each other's way. The surgeon must decide whether he will perform the operation with the patient in the usual position, cutting from above downwards, or with the head and trunk in the Trendelenberg position, pillows being placed under the dorsal spine, or a chair under the foot of the table, the incision being now made from below upwards. Removal from above downwards, by leaving the division of the trachea to the last, is held by some to avoid the risk of the escape of blood and lotions into the trachea, and thus to avoid any need of using expensive and sometimes unreliable* tampon-cannulæ. A small aseptic sponge attached to silk will suffice to keep the blood out of the trachea, if placed in this tube above the tracheotomy-cannula either early in the operation when the larynx is divided from above downwards, or later on when the larynx is severed from the trachea, as will be more convenient to most operators. If no tracheotomy is performed either some time previously or immediately before the operation, the median incision being made, the trachea is usually first isolated and divided, and then a large tube inserted. Prof. Keen strongly urges (*loc. supra cit.*) the need of using the Trendelenberg position in this and all operations about the upper air-passages; one of the chief reasons for tracheotomy and the employment of a tampon-cannula will, he hopes, be thus avoided.

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* There is a tendency nowadays to dispense with the tampon-cannulæ, different kinds of which have been introduced in order to prevent fluids entering the trachea and air-passages. Kocher has lately dispensed with them altogether. Cannulæ with air- or water-tampons are liable to the serious drawbacks given below. On this account, if any be used, it seems best to employ ordinary cannulæ surrounded with aseptic sponge. Mr. Butlin prefers the tube recommended by Hahn, for these reasons: (1) It consists of an inner and an outer tube, the inner of which is the longer, projecting about an inch and a half in front of the shield so as to render the entrance of blood very unlikely. In order to prevent this projection inconveniencing the operator, it is made to bend down parallel with the trachea before it stands out at a right angle with the neck. (2) The outer tube is partly covered with a layer of compressed sponge, previously soaked in iodoform and ether (1 in 7). The sponge is fastened on by sutures and by silk tied round both its upper and lower ends. (3) About ten to twenty minutes after the introduction of the tube the sponge swells up from the absorption of moisture, and the entrance of liquids into the trachea is thus prevented. While the delay is an objection, this arrangement of sponge seems to hold the tube more steadily in position than the india-rubber bag of Trendelenberg's tampon, which is liable to become slippery, may burst during the operation, may allow the air to escape and thus become useless, while, in common with all cannulæ, its introduction may be followed by a stoppage of the breathing. If Hahn's tube is employed, it will be found somewhat difficult to adapt the right amount of sponge exactly to the lumen of the trachea. The tube must be so introduced as to fit snugly, and without any undue force or pressure.

If the operation be begun from above, an incision is first made from the lower border of the hyoid bone, exactly in the middle line, vertically down to the level of the first or second ring of the trachea, and a second at right angles to the first, either at the level of the hyoid bone or across the thyroid cartilage, in either case passing outwards to the sterno-mastoids. The vertical incision should go down to the thyroid and cricoid cartilages and trachea, the thyroid and cricoid cartilages being carefully severed in the middle line with stout scissors or cutting-forceps, the two halves separated with retractors, and the interior examined to see if partial removal of the larynx will be sufficient. The soft parts over the thyroid and cricoid are then raised *en masse* by inserting a blunt dissector or raspatory so close to the cartilages that the perichondrium itself is lifted up with its relation to the soft parts over it undisturbed. This separation is carried back as far as the middle of the junction of the larynx and pharynx.

The above method of working very close to the cartilages with a blunt instrument only has the conspicuous advantages of disturbing but little the soft parts and of causing but trifling hæmorrhage.*

Where the parts do not admit of the above step, for instance, where the cartilages are infiltrated, or where the parts outside—*e.g.*, glands—are found involved, and the operator decides to go on with the operation (p. 508), much severer steps are necessary. Flaps of skin and fascia are reflected, and the larynx exposed as freely as possible. Any enlarged glands now seen should be removed, and the crico-thyroid arteries secured. The sterno-hyoids, sterno-thyroids, and thyro-hyoids are next severed near the thyroid cartilage, and the lateral lobes of the thyroid gland carefully separated in the same way (*vide infra*), ligatures being tied at their junction with the isthmus, if needful. The soft parts at the sides which contain the large vessels, &c., are now carefully retracted, and, the larynx being drawn first to one side and then to the other, the constrictors are divided very close to their attachments to the cricoid and thyroid cartilages. The introduction of an œsophagus-bougie may facilitate this step, and save needless "button-holing," now and later on, if the œsophagus needs separating from the trachea (*vide infra*). The superior laryngeal vessels are next secured and divided as they enter the thyro-hyoid membrane.†

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* In thus raising the soft parts, by keeping close to the cartilages of the larynx, care should be taken not to separate needlessly the soft parts from the trachea. Some of these—*e.g.*, the lateral masses of the thyroid gland, which are now also detached with a blunt dissector—are useful in preventing descent of the trachea.

† Mr. Butlin, quoting from Hahn, advises that, in detaching the soft parts at the back of the larynx, blunt-pointed scissors should be used with a series of short snips.

The larynx is next detached from the trachea, the cricoid, or a small circle of this, being left, if possible, to give support later on to the artificial larynx.* If, however, there is any doubt as to the extent of the growth downwards, the division had better be made between the rings of the trachea itself. The lower end of the trachea is next to be carefully stitched to the skin with sterilised silk sutures, and a full-sized tracheotomy-tube, made sufficiently bulky by compressed gauze or drainage-tube, is put in to prevent blood, &c., descending; the end of the tube being closed with sterilised gauze pledgets attached to silk.

The removal of the larynx is next carried on from below upwards, especial care being taken, in the separation of the œsophagus from its connection to the trachea and larynx, not to button-hole it (Foulis), especially at its attachment to the cricoid. During this stage the larynx is kept dragged forwards with vulsellum-forceps or a sharp hook.

If, as the dissection is being carried upwards, the laryngo-pharyngeal junction is found to be infiltrated, the anterior and lateral walls of the pharynx must be removed as well. Should the surgeon decide now to remove the epiglottis,† the knife must be carried upwards through the thyro-hyoid ligament, so as to pass between the tongue and epiglottis, its course being controlled by the left forefinger passed into the mouth. If the epiglottis be left, the knife is carried through the thyro-hyoid membrane and the thyro-epiglottic ligaments as well.

As soon as the larynx is removed, attention should be paid to any bleeding points,‡ and the cut edges of the pharynx (if this has been partly removed) stitched most carefully with numerous sterilised silk sutures to the soft parts at the base of the tongue and about the hyoid bone; secure union being of the utmost importance to prevent infection of the wound by fluids from the mouth and, as with the cut trachea, burrowing in the cellular tissue of the neck.

The after-treatment is considered at p. 519.

PARTIAL REMOVAL OF THE LARYNX

(Figs. 206, 207, 208).

As it is quite unsettled which operation will, in the larger number of cases, give the best results, the following two will be given here—viz., (A) Removal of half the larynx; (B) Thyrotomy and removal of the diseased parts.

(A) *Unilateral Extirpation of the Larynx* may be made use of when, after exposing it, partially freeing it from the surrounding soft parts, and slitting it open, it is found that the disease is limited to one side.

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* Hahn, however, removes the cricoid cartilage in complete extirpation of the larynx, as he thinks that, if left, it interferes with deglutition.

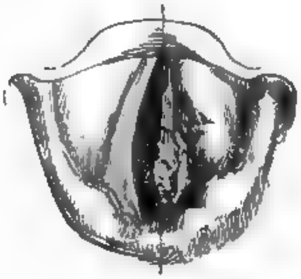
† "The weight of testimony seems to indicate the propriety of sacrificing the epiglottis in all cases of carcinoma, and in all others in which an artificial larynx is to be used" (Cohen).

‡ Numerous Spencer Wells's forceps and fine silk ligatures should be at hand, oozing being checked by very hot sponges wrung out of a mercury bichloride solution, 1 in 4000. The wound should be carefully swabbed out with the same solution at intervals from first to last.

The advantages of partial removal at present seem undoubted. 1) The mortality is less.* (2) The dangers of recurrence are not reater if cases are properly selected.† (3) The voice may be almost erfectly retained without use of the tracheal cannula. (4) Deglutition completely preserved.

Mr. Lennox Browne (*loc. supra cit.*), in his case of removal of half of the larynx 'igs. 206, 207, 208), having exposed it by sub-perichondrial raising of the soft parts, vided the thyroid cartilage with cutting-forceps, moved the half by (*a*) thorough separation of the tachments to the pharynx with the raspatory aided the knife-handle and finger-nail; (*b*) division of e thyro-hyoid membrane as close as possible to its yroid attachment; (*c*) division of the left superior rn of the thyroid cartilage at its root by cutting-liers; (*d*) division in the middle line of the cricoid rtilage, in front and behind; (*e*) the divided half f the larynx was then separated from the first ring f the trachea, and a few nicks only were necessary remove it entire. The very slight oozing § which sued after the removal of the diseased part was ecked by a light application of the galvano-cautery, hich would also destroy any possible fragments of iseased tissues not removed. The left arytæno-piglottic fold was divided close to the cartilage of risberg, and the thyro-hyoid membrane close to its yroid attachment, with the view of impairing as tle as possible the action of the epiglottis. The success of this plan was completely own by the ease with which deglutition was effected three days later.

FIG. 206.‡



Epithelioma of the left cord. From a patient in whom Mr. Lennox Browne successfully removed half the larynx.

(B) *Thyrotomy and Removal of the Diseased Parts.*—Mr. Butlin (*Oper. urg. Mal. Dis.*, p. 191) is in favour of thus limiting the operation. When the disease is of very small extent, limited to the true and alse cords of one side, not extending into the structures above and elow, not even adherent to the cartilage, I believe the better course o pursue will be to remove the diseased structures and a wide area of he surrounding soft tissues, just in the same manner as one treats an epithelioma of the lip, without insisting on the removal of even one-half of the thyroid cartilage. Cartilage, whether calcified or not, is peculiarly resistant to the progress of cancer, and when the disease appears to be adherent to it, it is the perichondrium which is affected, and only in the rarest instances the cartilage itself. Cancer of the larynx far more often causes the death of the cartilage piece by piece than infiltrates it." While the above remarks, coming as they do from one who is distinguished for his knowledge of malignant disease, and for being one of the few English surgeons who have successfully extirpated half the larynx, are entitled to every respect, more cases are required before it is seen how far this very limited proceeding is justifiable in malignant disease. Cases of recurrence after limited operations on the larynx are given at pp. 513, 517, and there are many others. Mr. Butlin has on two occasions practised what he taught. Thus, he relates (*Clin. Soc. Trans.*, vol. xxii. p. 94) two cases of epithelioma (one in a woman aged 27) in which he successfully removed the disease without taking away the framework of the larynx.

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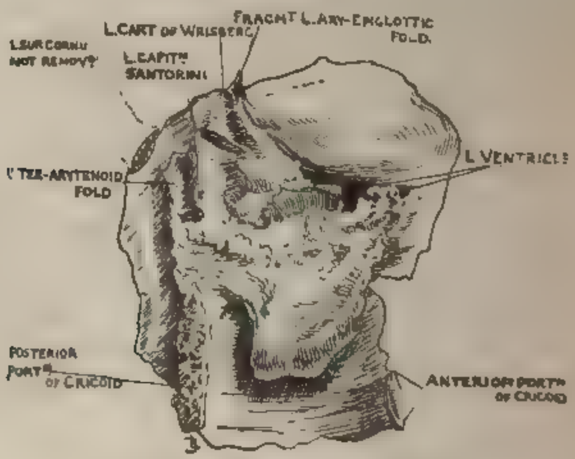
* Mr. Lennox Browne (*loc. supra cit.*) stated that some thirteen or fourteen cases had hen been recorded, and that in only one instance had there been an immediately fatal esult.

† Drs. Hahn and Schede (*Germ. Surg. Congr.*, April 1884; *Lond. Med. Record*, 1884, . 358) showed that (1) this operation was much less severe; (2) relapse was not more requent; (3) impairment of function was much less. In one of Schede's cases the atient was a dentist; he could, after a while, dispense with any cannula and follow is calling, his speech not attracting notice. As a result of cicatricial contraction, a rominent fold of mucous membrane had formed, immovable, but capable of performing many of the functions of the right cord, the left moving up to it, and thus forming a ima glottidis. In the case of a well-known barrister, operated on by Dr. Hahn, and rought by Dr. Semon before the Clinical Society (*Trans.*, vol. xx. p. 44; *Brit. Med. ourn.*, 1886, vol. ii. p. 975), the patient was able for some time to fill the position of a olice-magistrate. After a time the disease recurred.

‡ This and the next two illustrations will be found in Mr. Lennox Browne's paper *Brit. Med. Journ.*, Feb. 5, 1887) and in his book on *The Throat and its Diseases* . 457.

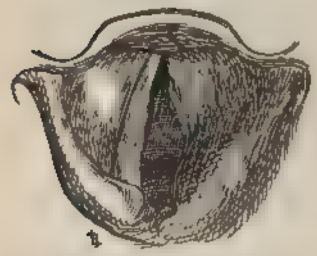
§ Only two small vessels required torsion—a happy result due to the use of the aspatory and to keeping so close to the cartilage.

Fig. 207.



Inner aspect of the portion removed.

Fig. 208



Laryngoscopic view from the same patient four months after operation

"Tracheotomy was performed, the first four tracheal rings were divided, and Hahn's tube was introduced. At the end of twelve minutes, when the sponge was sufficiently swollen to plug the trachea (p. 514), the thyroid and cricoid were divided, and the two sides held widely apart with blunt hooks. The exposure of the growth was excellent. The disease was much more extensive than had been suspected; it occupied the ant. commissure, the margins and under surfaces of both vocal cords and the subglottic region, and penetrated deeply into the adjacent tissues, reaching in two places down to the cartilage, but not eating into its substance. I cut it out very freely with scissors, and craped the edges of the wound with a Volkmann's sharp spoon, laying the cartilage quite bare. The larynx was left open, dusted with iodoform, and plugged with iodoform gauze. On the following day, Hahn's tube was replaced by a large silver tracheotomy-tube wrapped round with iodoform gauze." The patient was fed by an india-rubber tube. Ten days later, the sides of the larynx being held apart, Vienna paste was applied to the former seat of the cancer; this produced some temporary irritation, which soon subsided, but Mr. Butlin doubts whether any good was effected, owing to the difficulty of keeping the parts free from mucus and saliva. Three weeks after the operation the tracheotomy-tube was removed. In the other patient a similar operation was performed, but the cricoid was not divided; "the exposure was as good as could have been desired." The Hahn's tube was removed the day after the operation, but not replaced by another tube. Mr. Butlin kindly informs me (June 1895) that "both these cases were well more than three years after operation."

The chief explanation of this very happy result is the fact that the disease in each case was of limited extent. The first patient was able o speak in a hoarse voice, the second in a hoarse whisper. Microcopical examination of fragments previously removed* had proved the existence of epithelioma.

After-treatment.—All hæmorrhage being arrested,† one or two sutures may be placed at the ends of any transverse incision, but the vertical ncision should be left widely open for drainage, the wound being lightly packed with strips of iodoform gauze wrung out of carbolic acid lotion (1 in 20). The dressings should not be changed too frequently, and, at each renewal, the wound should be carefully swabbed out with some antiseptic solution and cleansed with sterilised camel's-hair brushes. Thiersch, to prevent lung infection, keeps the head low for the first few days. Prof. Keen (*loc. supra cit.*) kept his patient in the Trendelenberg position (by placing a chair under the foot of the bed) for one day. On the second day the bed was lowered into the horizontal position, and on the third day the patient sat up with a bed-rest. The trachea should be kept well plugged. Mr. Butlin advises that an ordinary tracheotomy-tube covered with iodoform gauze be substituted for the compressed sponge at the end of twenty-four hours. The gauze should be sufficiently thick to stop any discharges getting into the trachea, and should be changed once a day. It is very important to keep the wound sweet and clean to prevent the pneumonia which has so frequently proved fatal after excision. The inspired air should be charged with antiseptic vapours. Nourishment must be supplied, for the first week, or until the wound is consolidated, by a soft tube* passed either by the nose or mouth, and, if it is desirable to retain this, it would be well to make trial of this method before the operation. Feeding, save for just the first few hours, by enemata alone is not reliable considering the debilitated condition of these patients, and the profound shock which often accompanies this most serious operation.

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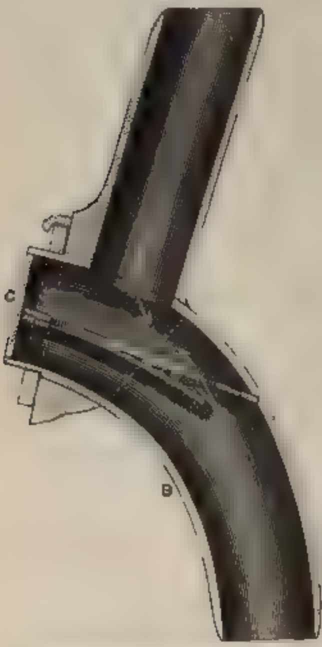
* It is noteworthy that, in the next paper to Mr. Butlin's, Dr. Newman sounds the following note of warning as to a possible result of intra-laryngeal removal of bits of growth for examination:—"While, on the one hand, intra-laryngeal excision for microscopic purposes clears up the diagnosis in carcinoma, it also exposes the patient to very serious dangers by increasing the rapidity of secondary new formations. The incision of a cancerous growth, or its partial removal, has justly been regarded as a most dangerous procedure, probably because the absorption of the infective material takes place rapidly from a wounded surface. For instance, judging from my own experience of other similar cases, I should say that neither in Case 2 nor 3 would the lymphatic glands have become involved for months had I not removed portions of the growth with forceps. In both instances the tumour was limited in size, and in both, within a very short time after the intra-laryngeal operation, the lymphatic glands became involved. . . . . While conscious of the value of removing portions of a laryngeal neoplasm for diagnostic purposes, I desire to express my strong conviction that it should not be resorted to in cases suspected to be cancer unless the patient is willing to have a radical operation performed immediately after the diagnosis is completed." A correspondence on the relation of intra-laryngeal surgery to malignant disease of the larynx will be found in the *Brit. Med. Journ.*, 1887, vol. ii.

† Iodoform itself must not be used too freely or too often, as iodoform poisoning may here develop very quickly.

FIG. 209.



Dr Foulis's modification of Gussenbauer's artificial larynx. A pharyngeal tube is seen above B. A tracheal cannula, the two having apertures by which they can be passed through each other and admit a free current from below upwards. C, An adjustable plate carrying a vibratory reed. This is detachable to allow of its being cleansed from mucus, being pushed in and out like a table-drawer. The apparatus being in position, the expiratory current, on its way to the mouth, sets the reed in vibration, and the tone thus produced, broken with articulate speech, is monotonous, modulation being impracticable. (Mackenzie.)

The temperature of the room must be from 65° to 70°. A layer of moistened gauze should be kept over the tracheotomy-tube, when this is retained. When the wound has become firm, the patient should be encouraged to take some solid food by the mouth, liquid food thus taken having, always, a greater tendency to get into the trachea.

The silk sutures uniting the cut trachea and the pharynx to the skin and soft parts must be removed as early as possible. This will be rendered difficult by the puckering-in and retraction of the wound area, which soon makes them inaccessible. If left to themselves they will come away very tediously. Prof. Keen, on this account, recommends the use of chromic gut or kangaroo tendon.

In about a month, an *artificial larynx* may be fitted, in those cases where this is possible (*vide infra*). Of these the chief forms are Gussenbauer's, and Irvine's modification of this.

After partial removal of the larynx, the patient will be able to dispense with the cannula, and to take food by the mouth within a few days of the operation.

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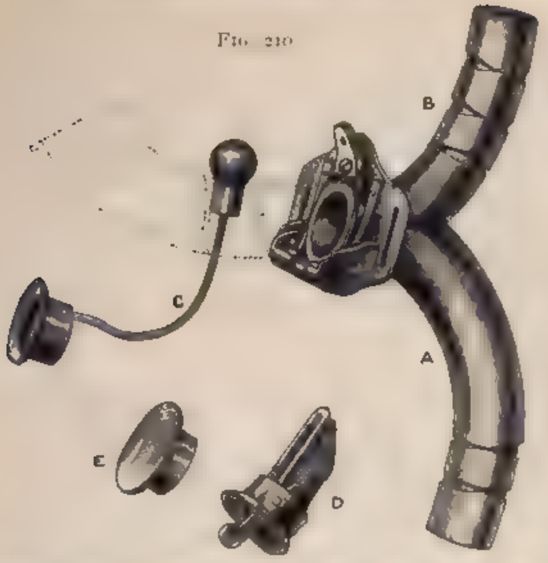
* In a case of total excision of the larynx by Mr. Morris (*Clin. Soc. Trans.* vol. xx. p. 37), feeding with an œsophageal tube became necessary about the second day owing to nutrient enemata not being retained. The patient took the strongest aversion to the tube, and Mr. Morris thought that the depressing influence upon the patient due to the loss of power of swallowing, and the prospect of having to submit to the use of the tube for some time, was not to be exaggerated.

FIG. 210.



Gussenbauer's artificial larynx.* (Park, *Ann. of Surg.*, Jan. 1886.) A, A large tracheal tube with rings below, corresponding to the natural flexibility of the trachea. Through its front plate and through an opening on its upper curvature passes a pharyngeal tube (B), also made flexible or not, according to the case, with an opening on its lower curved surface, so placed that a stream of air may play freely through both tubes, even though the external outlet be closed. The upper end of the pharyngeal tube lodges behind and below the epiglottis (if left),† or behind and below the base of the tongue. Around it the œsophagus granulates and closes, so that, when healing is complete, the only passage from the pharynx into the trachea is by way of the metal tube. In order that fluids and solids may not pass through this, an obturator (C) is provided, which is passed through the external opening and up through the tube, so that its rounded upper end plugs the upper end of the pharyngeal opening, thus preventing the passage of anything into the trachea. But since this would also shut off the air, the obturator is attached below, not to a solid plug, but to a ring, as seen, which fits accurately into the external opening of the instrument, through which the patient breathes as long as the plug is worn. Except at mealtimes a simple stopper (F) is worn, so that at all other times he breathes naturally through the nose and mouth. After a time, by education of the muscles, the upper end of the tube is protected during deglutition, and patients learn to swallow readily without the obturator. A substitute for the vocal cords is provided by a free metal reed, playing freely in a movable slotted bar (D). This movable bar carrying the reed has an external lever, by which the wearer can, with a touch of the finger, throw it in and out of the air-current, and thus, as it were, voluntarily open or close the glottis. The sound thus produced by the reed in the air-current is converted by the articulating parts above into distinct speech, the voice, though a monotone, being a perfect voice, save in pitch.

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[*] Dr. G. Fowler (*Amer. Journ. Med. Sci.*, 1889, p. 369) advises that this should be made of aluminium rather than silver or hard rubber, on account of the lightness of the former metal.

[†] Originally a substitute for the epiglottis was provided, maintained erect by a watch-spring weak enough to yield readily to the descent of the base of the tongue in deglutition. This has been found unnecessary and rather in the way. Dr. Cohen, of Philadelphia (*Internat. Encycl. Surg.*, vol. v, p. 777), figures an instance of the very complicated apparatus which will be required when the anterior wall of the œsophagus has been removed. As I have stated above, the tendency at the present day is to dispense with the different kinds of artificial larynx. I would here acknowledge my obligations to Dr. Cohen's clear and practical article.

In an interesting case under the care of Dr. Macdonald and Mr. Symonds (*Clin. Soc. Trans.*, vol. xxii. p. 253), the patient, after complete laryngectomy, could speak in a loud, though rough, voice which was not monotonous. This was produced by the vibration of two folds of mucous membrane of the pharynx. The patient could speak better without than with an upper tube, but the latter was necessary to keep the channel open. The dates in this case are as follows. The left half of the larynx was removed Oct. 1888, an uninterrupted recovery taking place. Dyspnœa soon after appeared, requiring tracheotomy, Dec. 16. It was found that the right side of the larynx was attacked by rapid and extensive growth, and the larynx was completely extirpated, Dec. 22, seven weeks after the first operation. The recovery was again an excellent one. June 19, 1889, a growth the size of a hen's egg occupied the lower half of the right anterior triangle. July 5, it is reported that the patient appeared to have but a few weeks to live.

Great difference is presented in the toleration of these appliances. In some instances they give little trouble, and are used with great comfort. Some subjects bear the naked apparatus well, but cannot tolerate the phonal reed, which may impede respiration, may become obstructed with desiccated mucus, and may yield a tone to every breath of expiration. Some abandon them altogether, and stick to the simple tracheal cannula.* In some instances saliva, mucus, and food will get into the tubes and descend into the trachea. Some patients prevent the escape of food by plugging the upper orifice when they eat. This fills the place of the obturator, C, Fig. 210.

With regard to those cases where no artificial larynx can be worn, Prof. Keen rightly remarks, "The possession of voice is nothing when compared with a speedy recovery and a greatly diminished danger of a fatal result." As a rule such patients can make themselves understood when the listener is close to them and the room quiet. A small slate or pad is also easily carried by the patient.

Dangers and Causes of Death.

1. Shock. 2. Exhaustion. Either of these is rarely met with, save when the hæmorrhage has been severe. 3. Suffocation from blocking of the tube during the first few days. 4. Lung trouble—viz., broncho-pneumonia, purulent bronchitis, &c. This is the most frequent cause of death, from the passage of food, blood, &c., down the trachea in spite of careful plugging.† Dr. Cohen thinks that the period of danger from lung complications does not last over two weeks, and that if the patient survive this date he is tolerably secure up to the fourth month, when death from recurrence begins to be imminent. 5. Septic cellulitis, mediastinitis, &c., only to be met by the most unremitting use of antiseptic precautions. 6. Secondary hæmorrhage. This occurred in Dr. McLeod's case (*loc. supra cit.*), on the fifth day, causing death rapidly. Its source could not be determined. The disease was extensive. 7. In two cases, certainly, of partial excision of the larynx, stenosis has followed (*Ann. of Surg.*, 1891, vol. xiii. p. 66).

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* This must be worn from time to time, according to the risk of contraction.

† If the patient have, previous to the operation, any bronchitis, these fatal lung complications are especially likely, the bronchitis running on into broncho-pneumonia. For this reason Billroth (*Clin. Surg.*, p. 134) urges in such patients that every attempt should be made to improve the bronchitis, a preliminary tracheotomy being performed if needful.

While these pages are passing through the press, the second edition of Mr. Butlin's *Operative Treatment of Malignant Diseases* has come into my hands.

The following conclusions of his on operations for malignant disease of the larynx will be read with much interest:—

"Endo-laryngeal operations are only indicated in these cases in which the disease is very limited in extent, very superficial, and in which there are very urgent reasons against opening the larynx.

"Thyrotomy is *the* operation for all cases of carcinoma in which the disease is limited to the interior of the larynx. It is seldom necessary in such cases to remove any of the framework of the larynx, unless the disease is situated at the back of the larynx. It suffices to scrape or cut away the face of the cartilage beneath the base of the disease.

"In those rare cases in which intrinsic carcinoma is associated with affection of the cervical glands, it is better to remove the glands by a separate operation.

"Thyrotomy is, to my mind, a safer and more satisfactory operation than the various modifications of pharyngotomy for removal of cancer of the epiglottis and aryepiglottic folds, &c. It allows of better exposure of the disease, and of greater certainty in dealing with it, and it appears to be less dangerous to life.

"Partial excision of the larynx, either of one half, or an atypical operation adapted to the extent and character of the disease, is suitable to cases in which the disease is of greater extent than could be dealt with satisfactorily by thyrotomy and removal of the soft parts. It is also indicated in those cases in which recurrence has followed rapidly on a carefully executed thyrotomy.

"Total extirpation of the larynx is very seldom performed in this country, and is losing favour in other countries. If the disease is too extensive to be treated by partial laryngotomy, the prospect of success from an operation is exceedingly bad. The operation itself is very dangerous to life. The patient is much more liable after it to affections of the lungs, particularly to fatal pneumonia; and the mutilation caused by the operation is often so considerable that the patient's lot is very unenviable.

"The operations which are suitable for the removal of carcinoma are equally suitable for the removal of sarcoma.

"The most promising cases of carcinoma for operation are those in which the disease is of intrinsic origin, situated on the vocal cord, near its anterior end, and is of small extent and not deeply fixed. And the best patients are those who are otherwise in good health, and particularly those who are not subject to bronchitis. Sarcomata of small size and of intrinsic origin are probably equally promising for operation.

"Cancers of extrinsic origin are always much less favourable for operation. The mere removal of the disease is more dangerous to life; while the greater local malignancy of the disease, and the early disposition to affect the lymphatic glands, render the prospect of cure very remote.

"I believe, in these cases, it is better to limit the operation to the larynx, and to remove the lymphatic glands if they are enlarged, through a separate incision, two or three weeks after the removal of the cancer of the larynx."

CHAPTER XIII.

OPERATIONS ON THE THYROID GLAND.

REMOVAL OF THE THYROID GLAND,* PARTIAL AND COMPLETE.

Indications.

1. Failure of previous treatment and increase of the bronchocele, leading to —2. Dyspnœa sufficiently constant to prevent the patient from following any active employment, or one of a sedentary kind which involves stooping of the neck and head. 3. The existence of tracheal stridor, especially if accompanied by enlargement of the isthmus (see p. 529), or extension of the lobes laterally or downwards.

I have met with several excellent cases of lateral compression of the trachea by the thyroid. The first patient was sent to me by Dr. Fraser, of Romford, nine years ago. Here the marked tracheal stridor, breathlessness on any exertion, but only weakened voice, were accounted for by the windpipe being in this case a well-defined instance of "the scabbard trachea," the tube being bluntly keel-like in front, with concave surfaces from the strap-like pressure of the enlarged isthmus. The sides of the thyroid cartilage showed, from the same cause, very marked concavities. A good recovery followed removal of the isthmus and one lateral lobe, and the patient, instead of being a nervous, exacting invalid at home, was able to take up work as a nurse in one of the London hospitals.

4. Attacks of sudden, suffocating dyspnœa.

It is not yet sufficiently recognised by the profession that a bronchocele, whether it be moderate in size or large, may from some sudden engorgement or rupture of its vessels cause urgent and fatal dyspnœa. A first attack may here only herald in the end.†

The following may be quoted to prove that the above danger is well founded :—

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* A distinction must always be made in these operations between removal of parts of the thyroid itself and that of encapsulated adenomata in it (p. 543), however large.

† Thus, in one case, a woman with a bronchocele which, as far as was known, had not given previous trouble, waking out of sleep suddenly, was terrified by seeing her little child playing about the room with a piece of wood taken alight from the fire. Most urgent dyspnœa set in, and, before surgical relief could be given, death took place from suffocation. In another case, that of a woman the subject of a bronchocele, and straining violently in the throes of parturition, similar dyspnœa set in as rapidly, and with *the same* result.

Dr. Hurry (*Lancet*, March 19, 1887) relates the case of a girl, aged 13, the subject of a moderate goitre. Dyspnœa was first complained of on Nov. 3. On Nov. 7, dyspnœa was urgent, and tracheotomy was called for. The operation gave very little relief, and death followed an hour and a half later. The necropsy showed a moderately large goître, the two lobes of which entirely encircled the trachea and reduced the lumen to a narrow slit, to which the tracheotomy wound did not quite reach.

Dr. Hurry gives the following ingenious explanation of the insidiousness and urgency of the dyspnœa in these cases: Owing to the slowly progressive enlargement of the thyroid the dyspnœa at first is slight; one day some extra exertion calls into play the additional muscles of respiration—*e.g.*, sterno-mastoid, sterno-thyroid, sterno-hyoid,—which, pressing on the trachea, still further close its lumen, already narrowed by the slowly progressive growth. This brings about additional dyspnœa, and so induces more vigorous contraction of the inspiratory muscles, and so further closure of the trachea, and finally fatal dyspnœa.

Dr. Dewes (*Brit. Med. Journ.*, Jan. 18, 1879, p. 84) records the case of a patient who was found by the Coventry police apparently dying of suffocation. On his admission into the hospital a large bronchocele was found, and a free median incision was made by Mr. Read down to the tumour. The breathing at once improved and soon became natural, the tumour decreased in size, and all went well till the evening of the seventh day, when the dyspnœa suddenly returned, the tumour again enlarging, and the patient dying in two or three minutes. It was found at the necropsy that in the last agony the posterior part of the tumour had broken down, giving rise to a large extravasation of venous blood, pressing on the respiratory nerves. "The only part of the trachea at all approachable was under the manubrium sterni, where it was covered by the innominate artery."

I wish to draw attention to another fact, that extravasation may take place suddenly into a bronchocele, and thus produce urgent dyspnœa.

In 1885 a woman, aged 44, came under my care with enlargement of the thyroid, the right half having been increasing in size for some years, but her chief trouble was due to a swelling, in the position of the isthmus, of the size of a small orange. This had existed about a year, but had suddenly increased in size, while the patient was singing, six months before. The patient's voice, originally an alto, was now hoarse and gruff, and of very small compass. Removal of the isthmus showed that this was occupied by a cyst, containing in the centre firm coagulum. Two years later, when the patient was last seen, the right lobe had subsided to the size of its fellow, but the voice was still deep and somewhat hoarse.

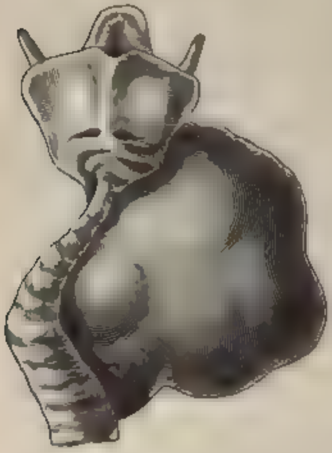
Occasionally it may be an accessory thyroid, not the main gland itself, which is the cause of the dyspnœa, and perhaps of death. Such a case is recorded and illustration is given by Mr. Bland Sutton (*Lancet*, vol. i. 1895, p. 462).

A man, æt. 36, was found lying on his back in a street adjoining the Middlesex Hospital, apparently in a fit. When brought in by the police he was dead. At the necropsy an accessory thyroid embedded in a thick fibrous capsule was found firmly fixed to the trachea in the neighbourhood of the fourth to the ninth cartilages. Though only about the size of a dove's egg, it had severely compressed the trachea and caused the fatal dyspnœa.

It will be well at this point to advise, in those ca
is suddenly and urgently demanded for goîtres

(1) If, as is very possible, the surgeon is short-handed,* and no adequate preparations have been made, it will be wiser to slit the deep cervical fascia, especially in cases where this is well developed, freely in the middle line, so as to allow the enlarged thyroid to bulge forward and away from the narrowed trachea. This, combined perhaps with venesection if much lividity be present, will very likely suffice for a time. But Mr. Read's case (*vide supra*), in which this step was adopted, shows that, by itself, it will not be enough. At the same time, if preparations can be made or as soon after as is possible, the isthmus and one lobe of the thyroid should be removed.†

FIG. 211.



This figure shows one way in which the trachea may be narrowed by a bronchocele, and how great the stenosis may be. If in addition there were pressure on the opposite recurrent pharyngeal nerve, or if an anæsthetic had to be given, it is obvious how easily a fatal result might follow. (Esmarch and Kowalzig.)

(2) If slitting up the deep cervical fascia does not suffice, the treatment lies between tracheotomy (if it be possible) or removal of the isthmus and one-half of the thyroid if the patient's condition on administration of the anæsthetic (A.C.E. or chloroform) admit of this operation. Where slitting up of the fascia is not sufficient, and where, owing to the urgency of the case, the fact that the needful preparations cannot be made, or the increased dyspnœa caused by the anæsthetic, removal of part of the gland is out of the question, tracheotomy is the only step left. **There are marked objections to it.** (*a*) It is often beset with great difficulties. Thus, if the surgeon open the trachea above the isthmus he is unlikely to have a suitable cannula at hand. In such cases a large-sized gum-elastic catheter, with the end cut off, as in Mr. Morton's case given below, or a full-sized Durham's cannula, with drainage-tube attached (p. 548), may suffice (unless there is sub-sternal enlargement of the thyroid) until a special cannula, such as that shown in Fig. 212, can be provided. (*β*) On the other hand, opening the trachea below the obstruction may be impossible, as in cases where a huge isthmus reaches from just below the cricoid cartilage to the manubrium sterni. Dividing such an isthmus and then performing tracheotomy may be accompanied by severe hæmorrhage and septic pneumonia. (*γ*) In cases where it is possible to open the trachea below the isthmus the difficulties of a low tracheotomy (p. 484) will be intensified, and the risks of encountering large vessels, such as the innominate artery, in a

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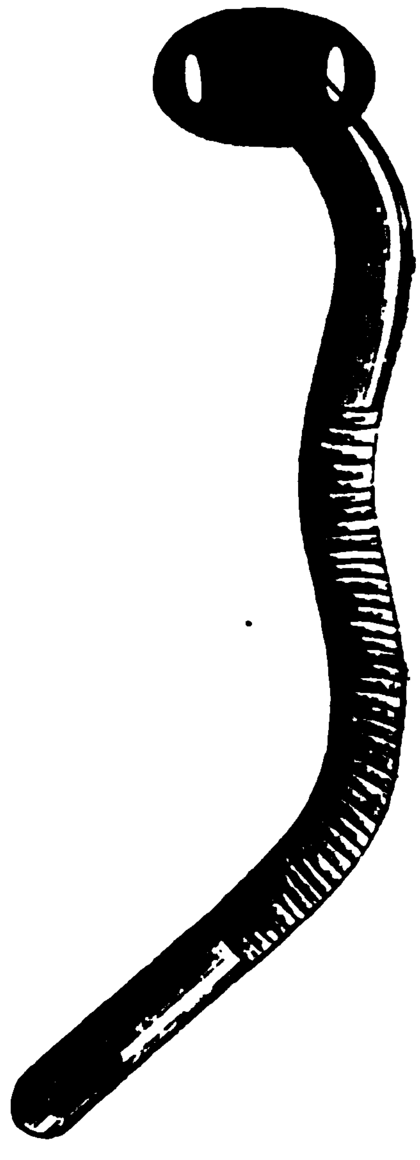
* The sudden onset of these most serious cases emphasises my opinion that treatment here to be successful should be *preventive*. Patients with the slightest degree of tracheal stridor and dyspnœa should be warned of the risk of suffocation, and operated on by removal of one lobe, before there is time for the last, and perhaps fatal, attack to occur.

† The cases given below show that division or removal of the isthmus by itself cannot be relied upon.

be remembered, while that of subsequent pneumonia is much increased. On the whole, a high tracheotomy, and the use at first of a gum-elastic catheter, is the less risky procedure to adopt. König's cannula (Fig. 212), if at hand, would be very useful. Where the goître, which is causing suffocation, is unilateral, the compression is due to a cyst or an adenoma, not to an ordinary goître. In the one case the cyst (probably containing blood, as in my case, p. 525, must be removed or drained (as in Mr. Bowlby's case, p. 529), in the other the surgeon should remove the enlarged lateral lobe if he cannot easily find and shell out the adenoma (p. 543). The following case by Mr. C. A. Morton (*Bristol Med.-Chir. Journ.*, Sept. 1896) of sudden dyspnœa in goître treated by tracheotomy and removal of the isthmus is most instructive:

Fig. 212.



König's flexible cannula for tracheotomy in cases of goître displacing or narrowing the trachea. (Esmarch and Kowalzig.)

A man, æt. 20, was admitted with tracheal stridor, due to enlargement of the thyroid of five years' duration, increasing rapidly during the previous fortnight. The isthmus covered the front of the trachea from the cricoid cartilage to the episternal notch. The lateral lobes extended widely outwards, the right carotid being pushed out to the posterior border of the sterno-mastoid. There was no pulsation in the goître. Two days later there was marked increase of the stridor during the night, and the patient could not lie down. It was settled to perform thyroidectomy the next day; but in the night the patient became rapidly cyanosed and unconscious. The house-surgeon performed laryngotomy and passed a large-sized gum-elastic catheter down the trachea. The cyanosis passed off, but the breathing remained considerably obstructed. When Mr. Morton saw the patient soon afterwards, the colour and pulse were very good. As it was found that, on stopping up the catheter, the breathing was as good as before, the instrument was removed. It was decided to remove the isthmus. As soon as the administration of chloroform was commenced, the breathing failed, the patient's colour became dull and leaden, and his pulse flagged. A long cannula (used for supra-pubic puncture of the bladder) was passed down the trachea, and very slowly the man began to take deep, whistling inspirations through it. The breathing gradually became normal. An incision was made from the entrance of the catheter in the crico-thyroid space down to the episternal notch, and the isthmus, which was of a dark mahogany colour, reached. As soon as the fascia over it was divided, it bulged into the wound. Two parallel silk ligatures were placed around the juncture of the isthmus and the left lobe, and the gland divided between them. Owing to the mass of tissue being so great, the ligature on the isthmus slipped off, and it was necessary to tie several vessels. The junction of the isthmus and right lobe was then ligatured by transfixing the gland-tissue with an aneurysm-needle, and using a double silk ligature. The portion of isthmus removed was slightly more than an inch in width. The trachea was of the typical keel-like shape from the cricoid cartilage to well below the episternal notch. Mr. Morton separated it freely from the lateral lobes with a blunt instrument, and divided all the fascia over it. So great was the general enlargement of the thyroid that the cut surfaces met over the trachea, although an inch of the isthmus had been removed. The hæmorrhage during the operation was never serious. A large-sized catheter was left in the trachea. For many days after the operation the patient was subject to a feeling of suffocation whenever the catheter was removed, so that it had to be replaced. About a fortnight after the operation it was found possible to leave it out for nearly a week, when the breathing became laboured and the instrument had to be replaced. It was finally dispensed with a month after the operation. Three days after the operation, pneumonia of the lower two-thirds of the right lung ensued, the signs of consolidation persisting for several weeks. Diminution of the thyroid, slow at first, was later on very marked, there being, two months after the operation, very little enlargement left in either lobe. The wound, infected by the laryngotomy wound, suppurated and healed by granulation. The patient was discharged in six weeks, and six months after the operation he could run upstairs without any dyspnœa; his breathing never again became laboured or stridulous. As is often the case after thyroidectomy in severe cases, the voice remained hoarse a year later. The larynx was normal. Probably, as suggested by Mr. Morton, the hoarseness was in this case due to interference with the action of the crico-thyroid muscle owing to the cicatrix in the crico-thyroid membrane.

The following cases show, I think, conclusively that, where removal of the isthmus does not relieve the dyspnœa, the whole of one lateral lobe should be removed. Taking this step will probably avert the need of tracheotomy, which renders a septic wound certain, and the onset of that most perilous complication, pneumonia, so very likely. No doubt, in some of these cases—Mr. Morton thinks in many—the dyspnœa will be too rapidly fatal for excision of one lobe to be undertaken for its relief. Dr. Lediard's case shows, however, what can be effected in severe cases.

The first was published by Mr. J. Marsh (*Birmingham Med.-Chir. Rev.*, 1894, vol. xxxvi. p. 271).

A girl, æt. 15, with a history of a goitre, uniformly enlarged, for six months, had for several weeks marked dyspnœa, and was said to have been almost suffocated on one or two occasions. The central portion with a part of each lateral lobe was resected. The lateral pressure had almost closed the lumen of the trachea. Removal of the pressure increased rather than diminished the dyspnœa, and on completion of the operation asphyxia was imminent, "the inspiratory efforts completely closing the trachea, which seemed to have lost all power of expansion."[*] Tracheotomy was performed, the largest tube available being only just sufficient. The remaining portions of the thyroid atrophied, but it was more than two months after the operation before the tube could be dispensed with, and then some dyspnœa and stridor still persisted; these did not disappear until a month later.

The second case, under the care of Dr. Lediard, of Carlisle, is reported by Dr. Stevenson (*Lancet*, vol. i. 1891, p. 1378).

A girl, æt. 16, was admitted for dyspnœa. She had noticed a goitre for two years, and for two weeks previous to her admission there had been great difficulty in breathing. The goitre was a large one, the right lobe being especially hypertrophied. There was marked tracheal stridor. Towards the evening of the day of admission the respiration became greatly embarrassed, cyanosis of the face being well marked, and consciousness being lost occasionally for brief intervals. Under the influence of chloroform the isthmus was removed. No relief of the breathing followed. The right lobe was now taken away, the operation being necessarily hurried, as the patient was *in extremis*. After this step the respiration rapidly improved. The patient made a good recovery, the breathing becoming perfectly normal, and the left lobe subsiding to a quarter of the size it was on the patient's admission.

In the following most instructive case the cause of the severe dyspnœa was a large cyst, post-sternal and intra-thoracic. It was dealt with successfully by drainage, by Mr. Bowlby (*Clin. Soc. Trans.*, 1895;

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[*] [illegible] ns, in addition to the marked narrowing of the trachea, that rare condition. [illegible] its structure, was also present in this case.

[illegible]

[illegible] Finally [illegible] situated. [illegible] weeks. [illegible]

5. D[illegible] [illegible]

6. S[illegible] [illegible] enlarge[illegible] [illegible] The lower [illegible] risk of [illegible] and the [illegible] dyspnœa [illegible] at extirpation.

The [illegible] p. 1921 is a [illegible]

A young man [illegible] paroxysmal attacks [illegible] whistling respiration, and some general enlargement of the base of the neck. Three days before his death this difficulty became extreme, the paroxysms became more frequent and more severe, and on the day of his death a severe paroxysm took place, which passed on to a forced and heaving respiration, beyond anything I had ever before witnessed, and speedy death resulted. I performed tracheotomy with the slender hope that some light might be thrown upon the nature of the case to guide us in its treatment, if not to give relief, but, in doing so, what was probable before became evident—viz., that the obstruction was below. I had no perforated instrument with me long enough to force down, so a female catheter was used, but it struck against some solid body that prevented its progress. After death the thyroid body was found to be much enlarged, but mainly below the sternum and along the sides of the trachea. The trachea below my opening was flattened laterally to within half an inch of the bifurcation; it was also twisted to the left, and was surrounded by the greatly enlarged and firm lateral lobes of the thyroid."

7. Inability to stoop without "a sensation of blood to the head," dizziness.

This was very marked in a man, aged 48, sent to me by Dr. Graham, of Pulborough, with general enlargement of the thyroid, especially of the left lobe. Removal of this and the isthmus was followed by great shrinking of the right lobe, the patient being enabled to follow his occupation of brickmaking in comfort.

8. Inability to sleep lying down.

A woman, aged 38, under my care, whose mother had died at 43 from suffocation by a bronchocele, was much troubled by the above symptom. Entire relief followed removal of the largest lobe and the isthmus.

9. Constant dragging pain in the neck. This will be met with in large and weighty tumours.

10. Improvement of personal appearance. An operation should never be here entertained by the surgeon, unless he is absolutely certain that he may have confidence in himself and his patient to be able to keep the wound aseptic from first to last.*

11. Exophthalmic goître. Surgical interference here is considered at p. 545.

Cases in which an operation is contraindicated, or in which it must be performed with additional caution.

1. Huge bronchoceles, especially if broadly fixed. 2. Calcified bronchoceles. 3. Those with ill-defined limits. 4. Those which are already sub-sternal, owing to the risk of mediastinal cellulitis. 5. Age—*e.g.*, in patients over 40. I refer here to bronchoceles which are certainly stationary. But as malignant disease usually intervenes not on healthy but on enlarged thyroid glands, it will be justifiable to run risk and to operate about the time of middle life or later if a bronchocele shows any sign of enlarging. But all bronchoceles which persist should be removed, by competent hands, at a much earlier age, on account of this risk of possible supervention of malignant disease. 6. Patients with very feeble pulse. Schwartz thinks that feeble action of the heart will be often met with in goître, and attributes this partly to interference with

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* The following is the advice of Billroth: "Large prominent bronchoceles in people above 40 years of age, with slight or no dyspnœa, should not be operated on just for the sake of appearance. I think that small bronchoceles connected to the lower part of the thyroid in children and young people should be more often removed, especially when their situation is such that the tumour might, with increased growth, possibly entail some danger."

respiration due to pressure on the veins and the trachea, and partly to the intervention of a more or less voluminous vascular network in the circulation, thus producing a strain on the heart. 7. Cases which appear to be allied to Graves's disease, though not presenting the typical symptoms. I think there is no doubt that there is a class of bronchoceles which form a connecting link between ordinary goîtres and those in which the typical evidence of Graves's disease is present. Such cases are always to be approached, from the operative point of view, with anxiety, as there is a distinct risk of a fatal ending from excessively rapid action of the heart, pyrexia, and perhaps lung trouble. The class I refer to presents many of the following points. The patient is usually a young adolescent, the bronchocele a soft parenchymatous one, affecting the whole gland, with evidently marked vascularity, and perhaps pulsation. The pulse is perhaps 100, and the heart is easily excitable. A soft systolic bruit may be present. Soon after the recovery from the operation the patient becomes restless and anxious. There is a constant attempt to clear the throat by coughing (this disturbs the wound extremely), and the patient complains of a dread of suffocation from a slight collection of mucus in the trachea and larger bronchial tubes. The position in bed is constantly shifted. The pulse mounts up to 120 or 130, the temperature rises, and exhaustion may soon follow. If the patient's strength is maintained the wound does not heal by primary union. The discharge, at first blood-stained, is profuse for several days, though sweet throughout. While the above train of symptoms, and particularly the restlessness, is likely to be met with after operations on cases of exophthalmic goître, it certainly follows where the typical collection of symptoms which characterise Graves's disease is absent. Surgeons should bear in mind the class of case to which I have drawn attention above.

Mr. F. P. Paul, of Liverpool, has given the following explanation in an instructive paper (*Brit. Med. Journ.*, Jan. 1, 1898, p. 17). After relating two cases, in both of which the above symptoms followed a few hours after the operation, one case proving fatal, while the other, a case of Graves's disease, recovered, he says:—"These two cases were the twenty-fifth and twenty-sixth operated on for thyroid enlargements, and I have done about ten since. None of the others were at any time dangerously ill, but I can now see that a few of them suffered from the same condition in a minor degree, and at about the same time. I therefore set myself to try and discover what could be the reason that an operation, which at first appeared so safe, should all at once have become so uncertain. Upon looking back, this explanation occurred to me: In the earlier operations I handled the gland very little, tying the vessels on each side before I divided them, and ligaturing the isthmus before separating the lobe. The operations then were longer, and more blood was lost. Indeed, in Graves's disease the hæmorrhage was sometimes alarming, for in these cases the blood wells out of the gland as if it was a saturated sponge. Gradually I came to grasp the gland firmly in the left hand until the thyroid arteries were secured, and in this way found that all serious bleeding was readily avoided. About the same time I gave up ligaturing the isthmus, as it appeared unnecessary. Now in these two changes it was probable that the danger lay. From barely handling the gland it had come to be firmly squeezed during most of the operation, and from securely tying the isthmus it had come to be cut straight across—and it must be remembered that in enlarged thyroids the isthmus is frequently upwards of an inch in diameter. I take it that squeezing the gland may help to liberate secretion contained in the follicles, and that the same may escape into the wound from the lymphatics in the divided capsule round the severed isthmus, the lymphatics being the normal channel for absorption of the secretion. If the condition from which these patients suffered is to be regarded as thyroidism, and not, as Mr. Horsley has said, athyroidism, then every possible source of contamination of the wound with thyroid secretion should be avoided. I cannot recommend that the safe grasp of the gland should be altogether given up; but I believe that it may be rendered harmless by first ligaturing the isthmus, and exercising caution in the amount of compression. My rule now is to ligature the isthmus early in the operation, handle the gland carefully, and at once, on the barest suggestion of the train of symptoms referred to, open up the wound, irrigate it, and fill with dry, aseptic, absorbent wool." In the first of the two cases related by Mr. Paul in the paper mentioned above, which ended fatally just two and a half days after the operation, the wound at the necropsy contained fluid of a very watery character. Believing that the grave symptoms were due to absorption of thyroid secretion, Mr. Paul, when his second case began to show symptoms which were a repetition of the first, about twenty-four hours after the operation, opened the wound and filled it with dry salicylic wool. This was followed by a marked improvement, but only for a time. During the second night after the operation the patient "became worse than ever; the temperature was 104·8°, the pulse almost uncountable, the respirations 36. I removed the plug of wool, and found it saturated with watery discharge, replaced it with dry wool, and left instructions that it was to be changed as often as it became moist, which proved to be about every two hours. The following day she was better in every way. The day after, the temperature was only just above normal, and continued so until convalescence was established, but the pulse and respirations went down more gradually."

While I never squeeze the gland, but limit the handling of it to shelling it out from adjacent important structures, and while I have never seen the watery secretion described by Mr. Paul, the course of the case has, on three or four occasions, so closely resembled that described by Mr. Paul, that I cannot doubt the explanation which he gives of this insidious and sometimes fatal complication is the correct one. I have below (p. 542) alluded to the question of treatment of the wound in cases which appear allied to the foregoing.

Dangers of the Operation—Immediate and Later.

1. Hæmorrhage. This can usually be met by paying careful attention to the details given below in the account of the operation. One of the most important points is to expose the growth thoroughly (1) by a sufficient incision, (2) by adequate retraction or division of the overlying muscles, and (3) by identifying the capsule itself. A mistake is often made here, and the difficulties of the operation largely and needlessly increased. The layers of deep cervical fascia over the thyroid vary greatly in individual cases. Every one must be divided, in the whole extent of the wound, before the bronchocele itself is dealt with.

This will be recognised by its peculiar colour (reddish-purple), its consistence, and the way in which the vessels ramify and stand out on its surface. The arteries are usually easily commanded; it is the veins which give trouble, being numerous and thin-walled, and, in the severer cases, met with at every step of the operation. In these cases also, when the growth is soft as well as vascular, any opening of the capsule is liable to give rise to flooding of the wound with blood, which makes it difficult to find the bleeding point, thus incurring risks of including in a ligature or otherwise injuring important parts, such as the recurrent laryngeal. Even in the removal of a small tumour, if soft and rapidly growing, most severe hæmorrhage may be met with, especially if the capsule be opened.

Thus, Mr. Foy (*Dub. Med. Journ.*, 1888, vol. i. p. 242), after shelling out a tumour the size of a hen's egg, met with such copious bleeding that the application of seven clip-forceps gave "no appreciable check to the flow." The wound was plugged with new sponges, kept in place by uniting the wound with wire and figure-of-eight sutures. The patient recovered.

2. Injury to the recurrent laryngeal nerve,* asphyxia, aphonia. This most grave accident has happened with sufficient frequency to put any surgeon on his guard. The injury may be due to including the nerve in a ligature, cutting the nerve, or seriously bruising it. Richelot, writing in 1885 (*L'Union Méd.*, Nos. 17 and 18, 1885; *Med. Chron.*, June 1885), found nine cases in which it was certain that the recurrent laryngeal had been cut during the operation. He gives the following causes of aphonia after the operation:—(1) Wound of inferior laryngeal nerve; (2) dragging of this nerve; (3) perhaps section of the crico-thyroid branch of the superior laryngeal; (4) months after operation it may come on from inclusion of the inferior laryngeal nerve in the cicatrix; (5) when the laryngeal symptoms are progressive from ascending neuritis (Schwartz). This may be present before the operation, and so, too, may be (6) compression of the inferior laryngeal by the goître.

Whatever be the exact cause, it is certain that the dyspnœa and aphonia are not always permanent. On this point the two following cases of M. Richelot, and mine at p. 534, are of much interest:

In a woman, aged 25, suffering from suffocating dyspnœa, the operation was followed by aphonia, which lasted for three months, and by complete paralysis of the cords. The operation was performed with great care, and there is no reason to think that either of the recurrents was cut, but it is possible that they were bruised or stretched; however, in four months the cords regained movement and the voice was fully restored.

In the second case, aged 20, a hard, mobile tumour, the size of a walnut, was attached to the isthmus by a narrow pedicle, and the gland itself, though apparently somewhat hypertrophied, was not prominent. But, when exposed, it was found that the tumour had a broad attachment to the isthmus, and that the two lobes of the thyroid were greatly hypertrophied, closely embracing and compressing the trachea; it was therefore thought desirable not only to remove the tumour, but also to dissect out the whole gland. When recovering from the effects of chloroform, the patient was suddenly seized with cyanosis and threatening asphyxia, and though she partially recovered, on the next day there was aphonia, dysphagia, and uninterrupted dyspnœa, and she died asphyxiated in the evening. Both recurrent laryngeals had been cut, and the upper end of the left one was included in a ligature.

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* Owing to the definite supply given to the muscles of each side by the corresponding nerve, actual laceration or division of the nerve will be followed by equally definite paralysis.

In June 1894—this being my fifteenth case of removal of the isthmus and one half of the thyroid—I met with this complication, which was, however, not permanent.

The patient was aged 35, the subject of an ordinary solid bronchocele of large dimensions, the right lobe being seven inches long. The voice was decidedly weak before the operation, but while this presented no difficulties and was not accompanied by any cyanosis, dyspnœa, &c., it was followed by marked aphonia, the voice being almost reduced to a loud whisper. The right vocal cord was now found to be motionless. Complete recovery had taken place when the patient was last seen in April 1895. I have recently (February 1899) seen this patient again, on account of a Colles's fracture. Her voice is good, though a little weak. Since 1895 she has been following her occupation as a cook.

Injury to the nerve is especially likely to occur under the following conditions: (*a*) when the growth is huge; (*b*) when it is very fixed by adhesions (which are uncommon), or by a broad base; (*c*) when it is ill-defined; (*d*) when it encircles the trachea and œsophagus closely; (*e*) when it is malignant. Advice as to the avoiding of this complication is given at p. 541.

3. Septic cellulitis leading to purulent and diffused mediastinitis. These are very likely if the wound becomes septic. In such cases the latter complication is almost certain, even in small goitres, if they dip down behind the sternum, owing to the difficulty of providing adequate drainage. The accompanying symptoms are pain in the region, coming on soon after the operation and increasing, followed by feebleness of the pulse, distress, and dyspnœa, and speedy death.

4. Myxœdema, both acute and more deferred. This strange condition, which has so unexpectedly overclouded otherwise successful operations for complete removal of an enlarged thyroid gland, was first noticed and published by two Swiss surgeons, Kocher and Reverdin.* The correct explanation will probably be found to be the one which Mr. Horsley brought before the profession in his lucid and convincing Brown Lectures of 1885.† The issues here treated are so wide, the experimental researches are so complete and far-reaching, that any abstract must, unintentionally, seem to do them an injustice. The following are the points of chief importance to the operating surgeon.

Effects of Excision; Phenomena following Complete Thyroidectomy in Monkeys.—"At a variable period after the operation, but averaging five days, the animal is found to have lost its appetite for a day or two, and, on closer examination, to exhibit slight constant fibrillar tremors in the muscles of the face and hands, and feet more especially. These tremors disappear at once on voluntary effort. At the same time, the animal is noticed to be growing pale and thin, in spite of the appetite, &c., returning quickly with great increase; rapidly the tremors increase, affect all the muscles of the body without exception, the animal becomes languid, paretic in its movements, and imbecile. Then puffiness of the eyelids and swelling of the abdomen follow, with increasing hebetude. During these last stages the temperature, gradually falling, becomes subnormal, and then the tremors disappear as they came. Meanwhile the pallor of the skin often becomes intense, and, leucocytosis having been well marked, oligæmia follows, and the animal dies perfectly comatose in a variable period, but usually about five or seven weeks after the operation."

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* *Arch. f. klin. Chir.*, Bd. xxix, S. 254, 1883.

† *Brit. Med. Journ.*, Jan. 17 and 31, 1885. "The Thyroid Gland: its Relation to the Pathology of Myxœdema and Cretinism, to the Question of the Surgical Treatment of Goitre, and to the General Nutrition of the Body."

Post-mortem Appearances met with after Complete Thyroidectomy.—Mr. Horsley thus sums these up:—"Ablation of the thyroid causes atrophic changes in the central nervous system, and in the fat generally. It causes an increase in the general connective tissue, and a mucoid conversion of the ground substance. This increase of mucin in the connective tissue is accompanied by an extraordinary secretion of the same stuff by means of the salivary glands, and also those of the alimentary canal."

While these changes are going on, the hæmapoietic tissues, especially the spleen, are found to have undergone obvious compensatory hypertrophy.

Theories explaining Myxœdema, Cachexia Strumipriva, and Cretinism. Mr. Horsley discussed the three following, he himself maintaining the third to be the correct one:—

i. Kocher's view, that the symptoms of myxœdema which follow complete thyroidectomy are brought about by chronic asphyxia, due to narrowing of the trachea, consequent on softening and atrophy, produced by ligature of the thyroid vessels which supply the trachea and œsophagus as well. Mr. Horsley finally disposes of this view by remarking that there are numerous cases of marked stenosis of the larynx and trachea on record, but not a symptom of myxœdema has here been noticed. Furthermore, in his experimental thyroidectomies, the larynx and trachea were found absolutely normal and patent.

ii. Dr. Hadden's view that the myxœdematous state of malnutrition is brought about by a general spasm of the arterioles and capillaries, the spasm being maintained by central disturbance in the sympathetic ganglia. This view regards the atrophy of the thyroid as due to constriction of the blood-vessels, and therefore of secondary importance. It has been accepted by Kocher on the assumption that in the operation the sympathetic nerves are injured and irritated by being included in the ligatures placed on the vessels. It is set aside by Mr. Horsley because (α) it has been found experimentally that, if the gland be exposed, and the nerves going to it divided, the symptoms of myxœdema do not appear; (β) in Mr. Horsley's experimental thyroidectomies which were followed by myxœdema, the irritation of the nerves was only, he considers, momentary; (γ) the sympathetic trunk and ganglia appear to be, microscopically, absolutely normal.

iii. The theory* that the varieties of a general state of malnutrition, given below, are due to the loss of function of the thyroid gland, perhaps through disturbance of the nervous centres, leading to vaso-motor or trophic changes in the tissues.*

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* Mr. Horsley also deals with some objections which have been raised to his theory—(1) Even if in the above-named conditions—viz., cretinism, myxœdema, cachexia strumipriva, and cachexia after thyroidectomy—a thyroid body be discovered post-mortem, it does not follow that this was in full normal function. (2) If one lobe be excised, the other hypertrophies; if this enlarged half be now removed, the animal presents many of the symptoms described. In answer to the statement of Schiff that, provided an interval of about three weeks elapses between the operations, the symptoms do not appear, or, at any rate, are not fatal, Mr. Horsley replies that even if the above observation is to be trusted the mitigation of symptoms can readily be understood, as the spleen will have had time to provide for the hæmapoietic functions of the gland.

Further detailed and most interesting information is given by Mr. Horsley, "The Functions of the Thyroid Gland" (*Brit. Med. Journ.*, 1892, vol. i. pp. 215, 265), and in his report as a member of the Clinical Society's Committee on Myxœdema. 1888. In the former of these papers (p. 268) he states his view as to the explanation of the myxœdema which may follow on complete thyroidectomy, as follows: "The thyroid gland possesses a power of metabolising certain intermediate waste products; if this metabolism should be interfered with, the consequence was disorganisation of the chemical changes (more especially those of the connective tissues), resulting in the imperfect performance of their normal processes, and consequently in their exhibiting this form of mucinoid degeneration."

The following cases, with the results of operation, support Mr. Horsley's views. They might be multiplied by other published cases, and it is probable that many other temporarily successful thyroidectomies have been followed by myxœdema, but that this ending of the cases has not been made known.

Volkovitch, of Kiev (*Lond. Med. Record*, 1885, p. 148), removed the whole gland, in a woman aged 38, for dyspnœa and dysphagia indicating operative interference. Death took place four months later, with marked evidence of "cachexia strumipriva"—*i.e.*, anæmia and weakness, tetany of hands and legs setting in five days after the operation, and becoming, later on, more general, numbness of hands, myxœdematous condition of the integument, striking apathy, and difficulty in articulation and respiration.

The late Sir W. Stokes published (*Brit. Med. Journ.*, Oct. 16, 1886) a case in which a somewhat similar fatal result followed complete thyroidectomy. A healthy woman, aged 18, was admitted with extensive enlargement of both thyroid lobes, causing urgent dyspnœa, especially at night. It was found impossible to remove more than the left lobe owing to the profuse hæmorrhage, which almost proved fatal. A good recovery took place, followed, for a while, by relief of dyspnœa and diminution in the size of the right lobe. In about six weeks, however, the right lobe was as large as before, and the thrill and dyspnœa were again present in an intensified form. The right lobe was removed with even greater danger from syncope. Within a fortnight convulsive seizures set in, and "fatty" swellings were noticed about the eyelids, backs of the wrists, and over the metatarsi. Mental torpor also appeared, and the aspect of the face became gradually one of imbecility. The convulsive seizures recurred, with lividity of the face, stertor, dyspnœa, protrusion of eyes, dilatation of the pupils, and throbbing of the carotids, followed by copious perspiration. The patient became weaker, and died, with symptoms of pulmonary infiltration, ten days after the second operation. The very brief account of the necropsy only mentions the brain, heart, and lungs; of these the two former "contained nothing abnormal, the lungs were highly œdematous."*

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* Mr. Horsley thus tabulates the most striking of the anatomical and physiological facts bearing upon experimental myxœdema:

"1. The thyroid gland appears to consist of two distinct portions—(*a*) glandular, consisting of highly vascular acini, which excrete into their interior a mucoid substance, this substance, or something closely similar, being found in the lymph-vessels of the gland—mucin-excreting function? (*b*) highly vascular, lymphoid nodules—hæmatogenous function.

"2. Excision of the gland is followed, according to my experiments, by an increase in the amount of mucin in the tissues which normally possess it, by a retrograde histological change, by an increase in the activity of the glands which normally excrete it, and, what is still more striking, by the assumption of the muciparous function by a gland which normally produces none, or very little mucin—the parotid gland.

"3. Excision of the gland is followed by profound changes in the blood—namely, a diminution of the number of corpuscles, preceded, as regards the number of the white elements, by a temporary increase in their number, by an alteration in the coagulability and albumins, and by an abnormal presence of mucin.

"4. Excision of the gland is followed by nerve-symptoms indicating changes in the lowest motor centres, these changes causing tremors, with rigidity and paresis; it is also followed by changes in the higher psycho-cortical centres, such producing imbecility, and, ultimately, death in the comatose state."

Mikulicz stated, some years ago, that the published cases of "cachexia strumipriva" after thyroidectomy already numbered thirty-five, and he adds another. As to other evils which may result from total thyroidectomy, he says that Weiss, in 1883, found thirteen cases of tetany, and Mikulicz himself has had four cases in seven operations. He also cites three cases (two of his own), in which epileptic convulsions followed total extirpation.

It is right to state that other observers have failed to trace the above sequence. Foremost among these is the experience of Billroth, who, in 1883, had performed extirpation sixty-eight times, with a mortality of only 7·3 per cent., and without once observing "cachexia strumipriva." Créde, of Dresden (*Congress of German Surg.*, 1884), reported fourteen cases of complete extirpation without one case of myxœdema following.

In the laborious Report of the Clinical Society on Myxœdema it is stated (p. 171) that myxœdema with cachexia followed in about 33 per cent. of all cases of complete thyroidectomy. Many cases will be found there quoted.

However this matter may finally be cleared up, the fact remains beyond dispute that in many parts of Europe symptoms akin to those of myxœdema have followed complete thyroidectomy.

Mr. Horsley (*loc. supra cit.*) shows that the following are modifying conditions in this consequence of thyroidectomy:—(1) The animal in question. Thus, while most severely marked in carnivora, he speaks of the cachexia as moderate, but certain, in man. (2) The age.† (3) The existence of accessory and residual thyroid tissue. (4) The previous state of nutrition; a state of low nutrition before thyroidectomy leading to early and very severe cachexia.

Why this sequence has not been invariable, and what the explanation of it is when it does appear, are as yet uncertain. But till this matter is cleared up, I am distinctly of opinion that complete extirpation of the thyroid is as yet unjustifiable in young subjects, or before the approach of middle life. It is certainly an operation of many undoubted risks, such as hæmorrhage, injury to the recurrent laryngeal (p. 533) and the trachea, and septic troubles. In addition, the great risk of myxœdema remains, an uncertainty perhaps, but still to be reckoned with. On the other hand, we have operations which are infinitely safer, such as ligature and removal of the isthmus, and removal of one half, to be followed, if needful, by ligature of the arteries to the opposite half later on.

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* In a similar case I would advise either ligature of the vessels to the remaining lobe, or removal of half of this. Possibly the administration of thyroid extract might have been beneficial.

† Of Kocher's sixteen cases, in which "cachexia strumipriva" was developed, nine were under twenty years of age, five between twenty and thirty, and only two above thirty. Eleven were young women; five were males.

The following case is the only one in which I have removed the entire thyroid. The points worthy of note are (1) that an interval of five years took place between the two operations by which removal was effected; (2) that the woman was 41 when the second lobe was removed, and that, though no thyroid extract was being taken, she was perfectly well when seen a year and seven months after the second operation; (3) that the diminution in size of the remaining lobe which followed on removal of the first and the isthmus was not permanent.

H. W., æt. 36, was sent to me at Guy's Hospital, in February 1893, for general enlargement of the thyroid gland. This had commenced when the patient was 16, then remained stationary till her marriage at 21. After each pregnancy the swelling had increased, and then gradually subsided. Following the birth of her last child, fourteen months before, the swelling had not subsided. The patient now had dyspnœa after exertion. As the left lobe had originally been the first to enlarge, and as it was now softer and more vascular than the right, this lobe and the isthmus were removed on February 17, 1893. The patient left the hospital on March 20, the wound being soundly healed. It is stated in the report that "the right lobe had diminished rapidly, all that was left of it being a small squarish mass."

In June 1898, or more than five years later, the patient reported that she was troubled with her breathing, and that after a long interval, being three months pregnant, she was very anxious about herself owing to the enlargement of the gland in previous pregnancies. She was re-admitted on June 28, 1898. The right lobe was about twice its proper size. There was no tracheal stridor. The right lobe was removed on June 28, the patient being now 41. She left the hospital on July 12, the wound being entirely healed. She took the thyroid extract for two months only, went her full time, and bore a healthy child. I saw her in February 1900, a year and seven months after the removal of the second lobe. There was not a trace of myxœdema; the general health was excellent.

Operation for Removal of One-half, and the Isthmus as well if required.*—I recommend this operation most strongly. I have performed it in 33 cases of ordinary bilateral bronchocele, and in 4 of exophthalmic goître. Of these 33 cases, 3 died; one a young male, with an enormous and rapidly increasing bronchocele extending behind the sternum, and causing grave dyspnœa. This patient sank within twenty-four hours, with symptoms which now appear to me referable to absorption of thyroid secretion (p. 531). The other, a woman of 44, died without any cause being found, save bronchitis. It is possible that this case may have, in some way, become septic. The third fatal case was one of exophthalmic goître, and is recorded below (p. 546).

In the very great majority, shrinking of the opposite half of the thyroid followed. In two cases—and it was not till I had operated thirteen times that I became familiar with this possibility—this desired end was only temporarily attained. After a few months the shrinking of the opposite lobe ceased, and it began again to enlarge. One of these cases is related above. It will be seen that the re-enlargement of the second lobe here caused no stridor, and that the dyspnœa was probably exaggerated and of nervous origin, the patient having suffered from real dyspnœa in past pregnancies, and having, after a long interval, become pregnant again. The four cases in which I have operated for exophthalmic goître are given below (p. 545). The parts having been sterilised, and the patient's head and shoulders conveniently supported, the anæsthetic is administered, A.C.E. being usually the best. If ether is thought necessary, it can be replaced by chloroform as soon as its stimulating effect is established. The surgeon now makes a free incision along the anterior border of the sterno-mastoid, over the most prominent part of the tumour which he is going to remove, avoiding any large veins. An ample longitudinal incision* will nearly always give all the room that is required, and such a scar will be little conspicuous, falling, as it does eventually, into the sulcus just internal to the muscle—a point of much importance in women.

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* I have (p. 543) compared this operation with one preferred by many surgeons, viz., removal of the adenomata which they maintain to be usually at the root of enlargement of one or both lobes of the thyroid.

The skin and platysma being cut through, any superficial veins carefully tied, the deep fascia is slit up, and one or more of the depressors of the hyoid bone, often much expanded, are next met with. These are separated with a blunt dissector, and divided if needful. I wish here to impress three points upon my juniors. The first, that all handling of the gland is to be as gentle as possible, for the reasons given at p. 531; and this is especially the case with soft, parenchymatous goîtres. Secondly, a pair of blunt-pointed curved scissors make a most efficient blunt dissector when used closed, while they are at hand in a moment to divide any structure required. Lastly, as I have emphasised at p. 532, the layers of deep cervical fascia met with vary much in strength, and, to a less degree, in number also. Every one of them must be divided in the full extent of the wound before any attempt is made to deal with the bronchocele itself. Inattention to this point will largely increase the difficulties met with. The goître in its capsule will be recognised by its bluish-red colour and the large veins which stand out as they ramify on the surface of the gland. One or more large retractors are now inserted so as to draw outwards the sterno-mastoid and large vessels, while the surgeon with his left index finger, or the scissors, frees the enlarged part of the thyroid from its bed, shelling it forwards, and probably finds it only fixed above, below, and internally, by the thyroid vessels and the isthmus. In effecting this separation, the greatest care must be taken to work gently and to keep close to the tumour,† the veins being often much enlarged and thin-walled.‡ The upper extremity of the tumour being first isolated, the superior thyroid vessels are found and tied either with double ligatures of chromic catgut passed with an aneurysm-needle or divided between two pairs of Spencer Wells's forceps, the two ends being tied. This effected, the tumour is next isolated in a downward direction, and any outlying masses turned out from beneath the sterno-mastoid. The next step usually taken is similar isolation, ligature, and division of the inferior thyroids, but I prefer to take the isthmus next, being of opinion that the more the growth is freed and isolated, and the less fixed it is the more easily are the inferior thyroid vessels dealt with, and the less danger is there of damaging the recurrent laryngeal.

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* The incision can either be made as above, laterally, or it may be angular with a straight limb in the median line from hyoid to sternum, and one passing obliquely outwards and upwards from the upper end of the first. If the surgeon still persist in removing the whole gland, the incision may be Y-shaped. In cases such as that of Sir W. Mac Cormac (*loc. infra cit.*), where the skin is adherent after the use of setons, &c., the incisions must be made so as to enclose and remove the adherent skin and cicatrices.

† The capsule of the tumour must nowhere be opened. Such a step not only leads to flooding of the wound with blood, but thus also obscures and may lead to damage of important parts, *e.g.*, the recurrent laryngeal and trachea.

‡ While it is quite impossible to give any adequate idea of the number of vessels which may be met with in a large and difficult case, it will be well to recall the principal vein-trunks. The superior thyroid vessels enter at the upper angle; a little below these emerges laterally a superior accessory vein (Kocher). The same surgeon describes as constant a superior and inferior communicating vein as lying above and below the isthmus, the former joining the two superior thyroids, and the latter entering into the thyroidea ima vein. The inferior thyroid vessels pass behind the outer border of the

The separation of the isthmus is best effected with a steel director, care being taken to keep the isthmus as much off the trachea as possible, and the point of the director close to the isthmus. Mr. W. Spencer has published a very interesting case (*Ann. of Surg.*, May 1895), in which the isthmus and the trachea were most intimately united, although the thyroid gland seemed the seat of fibroid and not malignant degeneration.

The patient was a young woman with a thyroid normal in size and shape but of marked hardness. The pulse was 130 140. There was no exophthalmos. Stridor was present, loudest at the level of the isthmus. At the operation no line of demarcation could be made out between the isthmus and the trachea, so the isthmus and the adjacent part of each lateral lobe were shaved away from the trachea, leaving a portion about as large as the end of the thumb. The trachea thus exposed felt like a soft tube and was sucked in and blown out by inspiration and expiration. The cartilaginous rings had softened or disappeared. As the breathing was none the better for the removal of the isthmus, the trachea was opened immediately below the cricoid cartilage. The trachea below this point being seen to be narrowed to a chink, the incision was carried downwards through that part of the trachea which had been in contact with the thyroid, until cartilaginous rings were again met with. In a fortnight the patient was able to discard the tube and she made a good recovery, though the pulse-rate was still 120 a minute.

When this body has been sufficiently separated, it may be ligatured after transfixion with an aneurysm-needle carrying sterilised silk or

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thyroid, and for some distance behind it, before penetrating it with its several branches. A little above the inferior thyroid vessels emerges the inferior accessory thyroid vein. The anterior jugular will have to be dealt with, and the positions of the internal jugular and below, of the innominate veins will have to be remembered in the case of large tumours. The above veins are figured by Sir W. Mac Cormac (*loc. infra cit.*) in an illustration taken from Kocher. In a case which Mr. Jessop and Mr. Berry record (*St. Barth. Hosp. Rep.*, 1880, p. 103) the position of the internal jugular was worthy of special notice, lying, as it did, spread out upon the outer side of the left lobe of a large bronchocele. "Instead of bearing the normal relation to the carotid, it lay well in front of and *internal* to it. Consequently the pulsation of the artery in such cases is not a safe guide to the position of the vein. We wish to lay stress upon this point, since we believe that it is mainly to ignorance of this altered relation of vein to artery that the not uncommon accident of a wound of the vein during extirpation of the goitre is to be attributed. We believe that the explanation which Lucke gives of this abnormal relation is correct. The common carotid, having no branches, is displaced outwards by the goitre: the jugular, being attached by its branches to the front of the thyroid gland, cannot be displaced to an equal extent, and consequently comes to lie at first in front of, and also internal to, the artery." Whether the above statement that wound of the internal jugular is a "not uncommon accident" in these operations is correct, may, I think, be doubted, in this country at least. The above case is well worthy of perusal.

strong chromic gut,[*] or it may be carefully torn through with the point of a director, and each bleeding point secured. The latter step will usually suffice.[†] The amount of hæmorrhage met with in detaching and dividing the isthmus varies. If the separation is effected piecemeal, the bleeding is often very slight. This is probably accounted for by the fact that the intimacy of connection and continuity of structure between the halves of the thyroid and the isthmus varies much also; in many cases the connection is mainly by connective and a little glandular tissue, with very few vessels.

The tumour, now almost completely isolated, is drawn to one side, and especial care is taken before ligaturing the inferior thyroid vessels. These should be most carefully isolated and inspected, so as to avoid injury to, or including, the recurrent laryngeal. Owing to the fact that the trunk of the inferior thyroid artery does not come into relation with the recurrent laryngeal till both are close to the trachea, either the trunk of the vessel should be ligatured and cut at some distance from this tube, or its branches tied close to the gland. I prefer the latter course.

If the vessel be tied near the junction of cricoid and trachea, the nerve may very likely be included; and the same risk will be run if, at this stage especially, the wound be not kept dry and bloodless.

After the removal of the tumour, the wound should be examined for any bleeding points, and most thoroughly dried out.

The question of **drainage** now arises. The wound left after removal of one lobe only, if much enlarged, is often extensive and deep, the larynx, trachea, large vessels, and œsophagus being all exposed. In several of my cases the dome of the pleura has been seen rising and falling in the root of the neck. It is a very difficult wound to drain satisfactorily, as its lower part dips behind the sterno-clavicular junction. In cases of ordinary parenchymatous bronchocele, where the operation has been easy, and the parts but little disturbed, the surgeon will dispense with all drainage and trust to a dry wound and carefully-applied pressure so as to obliterate its cavity. In such cases, in order to obviate any collection occurring, all fluid, blood-clots, &c., should be most thoroughly sponged out before the wound is brought together, and gauze or a sterilised pad should be kept in the wound while the sutures are inserted. These last are best of sterilised salmon-gut. When they are all in place the gauze is withdrawn before the sutures are tied. The edges of the wound should be brought into most exact position to promote early and sound healing. It is not uncommon for the scar to show a distinct tendency to become keloid, especially in young subjects; this condition is, however, only a temporary one—a linear white scar will be the final result. Over the dressings in immediate contact with the wound, firm even pressure should be made with sterilised pads or salicylic wool, with the twofold object of distributing the discharges evenly over a large surface of dressings, and obliterating the cavity of the wound. And for the first week after the operation the same care should be taken to keep the dressings securely in position. This is especially difficult in a mobile part like the neck, and one which does not admit of much compression. The safest plan is to pass the gauze bandages under the axillæ (protected from chafing by wool) below, and to wind them over the chin and forehead above, all being made secure by continuous stitching. This alone will prevent the dressings slipping down and exposing the upper end of the wound, which is thus readily infected. A piece of jaconet should be so arranged as to prevent soiling of the upper dressings by discharges from the mouth. In certain cases it will be wiser to employ drainage or a substitute. Thus, in rare instances, where much disturbance of the parts laterally has been needful—in one of my cases the common carotid was displaced into the posterior triangle—it may be well to introduce a tube laterally by counter-puncture. In those cases of soft vascular parenchymatous goîtres where the train of symptoms described at p. 531 is so prone to follow—due, probably, as pointed out by Mr. Paul (p. 532), to absorption of thyroid secretion—and in all cases of exophthalmic goître, I advise strongly that salmon-gut sutures should be inserted, as advocated above, but not tied; the wound should be gently but thoroughly plugged with dry sterilised gauze (a note being taken of the number of pieces used). The sutures are left long, and the wound is dressed in the usual way. After a few days, when, owing to the sealing of the surface of the wound, there is no longer any danger of further escape and absorption of the thyroid secretion, the gauze should be removed (with the aid of nitrous oxide gas if needful) and the sutures carefully tightened.

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[*] All ligatures used should be of efficiently sterilised chromic gut. If by any mishap primary union be not secured, silk ligatures are liable to come away for many months. Thus Sir W. Mac Cormac relates (*Brit. Med. Journ.*, 1882, vol. ii. p. 231) a thyroidectomy lasting two hours, in which at least a hundred ligatures were used. Six months later a sinus was still discharging ligature-threads (*vide infra*, p. 552).

[†] If the pedicle seem too thick and vascular to treat in this way, which may be the case in colossal bronchoceles, it should be subdivided and tied in several pieces, like a stout ovarian pedicle, the ligatures being made to interlock. If this cannot be managed, and if the patient's condition admit of it, the pedicle may be slowly divided by an écraseur, or seared through with the cautery. In such case the stump should be brushed over with a solution of zinc chloride, gr. x.-ʒj., or one of formalin, packed round with sterilised iodoform gauze, and brought outside the wound.

One or two complications require notice.

If during the operation there is any evidence of syncope, the head should be lowered and injections of ether or brandy given. Both the surgeon and the assistant who is giving the anæsthetic must be on the look-out for evidence of dyspnœa or asphyxia. If any sign of these occur, it is an indication for the surgeon most carefully to examine the tissues which he is handling, and the amount to which he may be dragging upon the air-passages in the manipulation of the tumour.

Tracheotomy seems to be nearly always a fatal complication,* partly by rendering such a deep and important wound septic, partly by causing septic broncho-pneumonia, and partly by adding to the shock in a patient already collapsed by so severe an operation.

If tracheotomy appear urgently needed, the surgeon should try first slitting up more freely the deep cervical fascia or dividing any stretched muscles, in order to relieve the trachea and breathing.

In the event of this operation having to be performed, great difficulties must be expected, and the surgeon should be provided with long soft tubes, in case there is any mediastinal prolongation pressing upon the lower part of the trachea. Every possible attention must be paid to keeping the tracheotomy wound sweet with applications of iodoform, iodoform and ether, &c. Sir W. Mac Cormac mentions the need of keeping the head very steady during the tracheotomy, and, later on, with sand-bags; he advises leaving the thyroidectomy wound open, and treating it with frequent irrigation, if tracheotomy has been found necessary. Irrigation with mercury perchloride (1 in 4000) should be used at intervals throughout.

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* In five of Billroth's cases in which tracheotomy was performed, three died. Kocher's experience has been the same.

Enucleation of Thyroid Adenomata.—This method has been largely used by Porta, Billroth, Socin, Reverdin, Wölfler, and other continental surgeons. Mr. Symonds (*Clin. Soc. Trans.*, vol. xxiii. p. 51), following on the same lines, has shown that, in cases of ordinary solid enlargement of the thyroid, encapsuled adenomata are often present, and that it is sufficient and a much less severe operation to enucleate these instead of removing one half of the gland. In practising enucleation it is necessary, when the enlarged lobe has been exposed and brought well up into the wound, to search for and define most accurately the capsule of the adenoma. "In most cases it will be seen at once, but in a few the edge of the gland may have to be raised first. It is most essential to be sure that the smooth, white covering is exposed; for, if not, and the dissection be carried outside it, troublesome hæmorrhage is sure to follow: in fact, the entire success turns upon this point." Any surgeon adopting this method will remember (1) the above danger—a very present one—of hæmorrhage;* (2) the fact that these adenomata may be multiple,† and that if one be left behind it will keep up the enlargement of the lobe; (3) that shrinking of the opposite lobe, which it is our aim to bring about by removing one lobe, is not so likely to follow on removal of an adenoma as it is when one lobe and half the isthmus have been removed; (4) that enucleation is not applicable to all cases, *e.g.*, the gelatinous form of adenoma.

To quote Mr. Berry (*Birmingham Med. Rev.*, 1890, p. 333), the method is obviously suited only to those cases in which the adenoma forms a well-defined tumour embedded in the thyroid. Again, as pointed out by the same authority (*loc. supra cit.*, p. 332), it is only in the unilateral goîtres that the enlargement is brought about either by adenomata or cysts. Unilateral goîtres present themselves for treatment but rarely when compared with the cases of general enlargement, and, from my experience, cysts are much more frequently met with as the cause of unilateral enlargement of the thyroid than are adenomata. A careful examination of the specimens removed in the thirty-three cases in which I have operated has revealed adenomata in only five, and one of these lay too deep to be detected. Prof. Kocher (*Rev. de Chir.*, April 1898) considers that intra-glandular enucleation of isolated adenomatous nodules is only to be practised if they can be removed rapidly and without marked hæmorrhage, otherwise partial thyroidectomy is indicated.

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* Wölfler, in his exhaustive monograph (Berlin: A. Hirschwald, 1891), shows that this method, while successful in a great majority of cases, has proved fatal from hæmorrhage.

† Wölfler (*loc. supra cit.*) mentions a case in which as many as thirty or forty adenomata were present. He states that recurrence took place in one case after this method had been employed, but that, as most of the cases are too recent, nothing definite can be stated on this point.

Treatment of Enlarged Thyroid by Operations on the Isthmus.—This method consists in excising the isthmus after applying double ligatures, or in trusting to double ligatures alone. It was first recommended in this country by Sir D. Gibb (*Lancet*, 1875, vol. i. p. 120). and more recently by Mr. Sydney Jones.

In Sir D. Gibb's cases the patients were young women whose bronchoceles had resisted other treatment. In one case there was general enlargement of the thyroid, especially on the right side; the isthmus could be felt, distinctly rounded, and projecting somewhat over the trachea. Mr. Holthouse exposed the isthmus, and, after placing a ligature on either side, removed it. About six months later the patient was entirely free from her old symptoms—tension, dyspnœa, &c.—and the lobes appeared to have receded laterally, and to be less prominent.

In the second case there was much enlargement of the veins owing to extension downwards of the bronchocele. Cough, dysphagia, and, at times, urgent dyspnœa were present. When Mr. Holthouse exposed the isthmus it suddenly cropped up like a hernial tumour. After cautiously detaching it with curved scissors, two ligatures were passed under it as widely apart as possible. As they seemed likely to become detached if the isthmus was cut away, they were left in to slough out. The patient made a good recovery, with much relief to her symptoms.

Mr. Sydney Jones has recorded (*Lancet*, November 24, 1883) the case of a patient aged 18, who had noticed the swelling about eight years; latterly it had increased rapidly. The dyspnœa was marked, the least exertion bringing on paroxysms. The thyroid was greatly enlarged, the right lobe being much the larger, while the isthmus could be traced extending below its usual position, as a band about one inch in vertical measurement. An incision about three and a half inches long having been made in the middle line, and transverse branches of the anterior jugular vein tied and turned aside, the isthmus was detached by the finger and director from the front of the trachea. An aneurysm-needle was then made to perforate (which it did easily) the junction of the isthmus with each lateral lobe. The double ligature on each side was tied as with an ovarian pedicle, and the isthmus cut away. There was very little hæmorrhage. The trachea was much compressed, of triangular shape, with the apex forwards. and each lateral surface somewhat concave. Immediately on removal of the isthmus, much relief seemed to be afforded to the patient. The dyspnœa quickly ceased; and when the patient left, in less than two months, the thyroid could not be felt.

I have followed Mr. Sydney Jones in three cases, with a good result, the shrinking of the lateral lobes being steady and progressive. I cannot, however, say whether this has been permanent, and as in two cases, in which I had removed one lateral lobe as well as the isthmus, the other lobe, which had shrunk out of sight, began two and three years later to enlarge again, I have ceased to practise removal of the isthmus alone. But where dyspnœa is increasing, and slitting up of the deep fascia freely does not relieve it, especially in cases where the surgeon is short-handed, a trial of this method would be quite justifiable, though, as shown at p. 528, one lateral lobe should always be removed as well, if possible.

A trial of this operation would be also justified in the following cases. When the isthmus is distinctly enlarged in (*a*) cases of colossal growths where the surgeon does not care to undertake more;* (*β*) where, owing to the anæsthetic not being well taken, the time for operation is limited; (*γ*) where, the lateral lobes being little affected, the isthmus is the seat of the enlargement, especially if tracheal stridor be present. If with general enlargement dyspnœa be present, removal of one of the lateral lobes as well as the isthmus will give much more speedy and decided relief. I accordingly prefer the latter operation wherever the lateral lobes are much enlarged. The isthmus can be raised without difficulty with a steel director or blunt dissector from the trachea; it is then transfixed at its junction with the lateral lobes, or through these themselves, with a double sterilised sulphuro-chromic gut ligature (this should be tested beforehand). The ligatures being tied, the gland tissue is snipped through between them, the isthmus removed, and the stumps pared away as close to the remaining ligatures as is safe.

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* In these cases the shrinking of the lateral lobes may be slow.

Thyroidectomy for Exophthalmic Goître.—I have operated in four of these cases. It will be seen that in the two cases of which particulars have been obtainable some time after the operation, the relief given has not been complete. Further, that the fourth case was quickly fatal, and probably from over-absorption of thyroid secretion. As I have already stated, I believe these fatalities may be prevented by filling the wound with dry sterilised gauze at the close of the operation, in the manner suggested by Mr. Paul (pp. 532, 542),—but doing it at once, and not waiting, as he does, for the first onset of dangerous symptoms.

The first case was a patient, aged 22, of Dr. Garrard, of Rickmansworth. I operated by the advice of Dr. Goodhart. Proptosis had been noticed for three years, but the enlargement of the thyroid for only six months. Both lobes, especially the right, and the isthmus were much enlarged, the latter extending down to the sternum. The whole gland was spongy, and pulsated slightly, in addition to receiving pulsation from the carotids. A marked thrill could be felt over it. A venous bruit could be heard at the lower part of the right lobe, a systolic bruit over the pulmonary, and one much less marked over the aortic area. Slight attacks of dyspnœa had recently appeared, especially at night, "with wheezing." There was occasionally some difficulty in swallowing. Chloroform was taken quietly. An incision, about 7 in. long, being made from behind the right angle of the jaw to the left sterno-clavicular joint, the tumour was exposed by slitting up the deep fascia and partly dividing, partly retracting, the hyoid depressors. The three parts of the thyroid were intimately fused, thick, and fleshy; the isthmus had crept down to the manubrium. A very striking feature was five or six huge veins, the size of the axillary, coursing over the front of the tumour to dip down behind the sternum. The thyroid vessels on the right side were first found and tied, the inferior being dealt with by tying its branches very close to the gland, so as to avoid the recurrent laryngeal nerve. The right lobe was then dissected from the trachea with a steel director, the adhesions being intimately close by firm connective tissue not very vascular. The large veins already mentioned having been secured with double sulphuro-chromic gut ligatures, the isthmus was next freed from the trachea, and its junction with the left lobe carefully transfixed with a steel director. Along the director an aneurysm-needle loaded with stout gut was passed. The loop of this was drawn through and cut, and the two halves of the above junction tied tightly. The right lobe and the isthmus were then cut away. Recovery was most satisfactory, the patient being up on the eleventh day. There was still some throbbing over the left side, but this was no longer perceptible to the patient. The basic bruits had disappeared. This case, which was operated on now nearly six years ago, was for some time most successful. Two years after the operation she reported as follows: "I am much better; the swelling in my neck is scarcely to be seen. The palpitations are better, and my eyes not so prominent. I can walk over ten miles without feeling tired, and take my food well. I work at the machine from 8 a.m. till 8 p.m., dressmaking." But about three months later the patient reappeared, with a return of the swelling on the left side, eyeballs as prominent as before, shortness of breath, and palpitation of the heart. Since that time I have not seen her. The failure in this case, if it prove to be a failure, is largely due to the unhealthy conditions under which the patient lived. The second patient was under the care of my colleague, Dr. Wheaton, at the Royal Hospital for Children and Women. She made a good recovery from the operation, which took place four years ago, with distinct relief to the palpitations and exophthalmos, but I have not been able to learn the result.

The notes of the third case are as follows :—

Miss M. G., æt. 20, was brought to me by Dr. Taylor, of Acton, in June 1894, with exophthalmic goitre and the following history. Palpitation and shortness of breath were first noticed six months before, after an attack of influenza. Proptosis and the goitre followed. The enlargement of the thyroid is moderate in amount and uniform. Marked pulsation of the carotids. The usual murmur and thrill over the goitre. Systolic apex murmur. No cardiac hypertrophy. One marked symptom is the fidgetiness, restlessness, and irritability of the patient. There is also a constant short cough. As there is no tracheal stridor and no expectoration, this is probably largely nervous. Pulse-rate 130° 140°. Largest circumference of neck over the thyroid gland, 14½ inches. Palliative treatment with belladonna, digitalis, and thyroidin tabloids gave no good result. June 28: Removal of the right half of the thyroid (the larger lobe) and part of the isthmus. The operation presented no special difficulty, save with the isthmus, which was large and lobulated. This was peeled off the trachea up to its junction with the left lobe, transfixed with two sterilised silk interlocking ligatures and cut away, the stump being pared down to within a safe distance of the ligatures. For the first few days the patient's condition of incessant restlessness, with the consequent tax upon her feeble strength and the disturbance of the wound, gave rise to much anxiety. Save when under the influence of morphia, the patient was never still for more than a few minutes. She was constantly hawking and trying to expectorate, one moment on her back, then on one side. She complained greatly of the heat, and as soon as a sheet was drawn over her, she would pull it off again. Thanks to Dr Taylor's watchfulness, the patient made a good though slow recovery; the wound healed in eight days.

In June 1895, Dr Taylor reported as follows (it will be seen that though there was marked improvement, the operation had not effected a cure) :—" Proptosis less marked. Breathlessness better. Palpitation less. Measurement of neck now twelve inches. Patient was able to skate last winter, and can walk ordinary distances."

On April 23, 1900, Dr. Taylor wrote at my request :—" In my opinion the breathlessness is much improved, but the proptosis and palpitation on exertion are still marked. She is quite as restless and excitable as before. Her general health is very good. She is able to walk eight or ten miles at a stretch; the slightest hill, however, produces breathlessness and palpitation."

In the following, my fourth case, there was evidence of auto-intoxication or thyroidin-poisoning at the time of the operation, and perhaps it would have been wiser to defer the operation, though I am strongly of opinion, that, without operation, life would have closed quickly, and from the same cause, judging from other cases which I have seen.

C. D., æt. 25, was sent up to me, May 13, 1809, by Dr South, of St. Leonards, with an exophthalmic goitre affecting the whole gland, but especially the right lobe.* The trouble had begun eighteen months before, and had been steadily continuous in spite of varied treatment. Latterly there had been some interference with respiration, the patient's breath being short on exertion during the daytime, and at night there was a feeling of dread of suffocation on lying down. The loudness of the bruit and the distinctness of the thrill and pulsation made it somewhat difficult to be certain, but no tracheal stridor could be made out. The patient's pulse was from 120 130, T 100°. Her condition was one of great restlessness and agitation. While the above facts made operative interference very risky, prolonged treatment had failed, the swelling was steadily augmenting, and with this were already noticed a rising pulse-rate and temperature, and increasing restlessness and agitation. If I had sent the patient home, I believe that death would have soon followed with an increase in the above symptoms and cardiac failure. To defer the operation, and keep the patient in a general surgical ward to watch her, would, I consider, have been even more quickly harmful. Operation, in spite of its dangers, gave her a chance.

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* This enlargement of the isthmus was a marked feature: it reached from the thyroid cartilage to the manubrium. Very distinct thrill and pulsation were noticeable over the swelling, together with a loud, rasping bruit.

Her restlessness was certainly not greater than in Dr. A. E. Taylor's case, to which I have referred (a patient of about the same age), and she had recovered from the operation. Speaking now with more experience, I doubt if I should operate again on a case in which the pulse-rate, the temperature, and the restlessness were of such anxious omen as in these two cases. If I did operate I should adopt Mr. Paul's plan, and plug the wound with dry sterilised gauze.

The operation was on the afternoon of May 15. The only difficulties met with were the large size of the isthmus, and the firmness with which this and the right lobe were connected to each other and, by dense fascial layers, to the trachea. The junction of the isthmus and the right lobe was divided, partly by snipping through with scissors, partly by tearing through with a steel director. The stump left was pared down with scissors. The right lobe was unusually dense and showed no colloid change and no evidence of any adenomata or cysts. The pulse at the close of the operation was 140, and the same at 10 p.m., when the temperature was 103°. The patient from the time of the passing off of the anæsthetic had been constantly restless, throwing herself about. This condition continued, in spite of treatment, throughout the night and next day. The pulse-rate rose to 160 and 180, and the patient died suddenly from cardiac failure, about twenty-five hours after the operation. At the necropsy the wound looked natural; the only abnormal condition found was the presence of a good deal of sticky mucus in the bronchial tubes.

Removal of half or the whole of the thyroid gland has been practised in a large number of cases in Germany.* The cases show such a proportion of success as to justify resort to surgery in certain instances (*vide infra*). On the one hand, it is clear that removal of one half of the isthmus is often followed by rapid (within a few days) relief to the exophthalmos, palpitations, and pulse-rate. On the other, many of the cases published as cures are quite unreliable. Thus, Lemke (*loc. supra cit.*), who holds that all cases of morbus Basedowii are surgical, not medical, relies upon two successful cases published six and seven months after the operation. Again, the fragility of the capsule and of the vessels must be remembered in operations for this disease, and it will always be necessary to exercise the utmost caution with the anæsthetic, owing to possible conditions of the heart and large vessels.

Indications.—I think that partial excision is justified in those cases of exophthalmic goître where previous treatment has failed; in the rarer cases where dyspnœa is present or ulceration of the corneæ threatening, and where those distressing nervous symptoms, restlessness, excitability, &c., probably pointing to over-absorption of thyroid secretion, are present (p. 531), as in my third and fourth cases, operation is to be undertaken with the greatest caution, and only after putting both sides before the patient. Owing to the tendency to cardiac syncope in these cases the operation should not be deferred too long. In all cases, to prevent the absorption of the gland secretion, which is so especially dangerous in these patients, the wound should be filled with dry sterilised gauze for the first few days, as advised at pp. 532, 542.

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* Mannheim (*Morbus Gravesii*, Berlin, 1894), Wette (Langenbeck's *Arch. f. klin. Chir.*, Bd. xliv. pp. 785, 805), Lemke (*Deutsche Med. Woch.*, 1891), Hack (*ibid.*, 1886), Rehn (*Berlin. Klin. Woch.*, 1884).

Question of Operation in Cases of Malignant Disease of the Thyroid.—The surgeon must consider here most carefully whether any operation is justifiable. In the first place, the risk of injury to the recurrent laryngeal is much increased from the tendency of a malignant growth to creep round the trachea, dip into the sulci between the large vessels and the windpipe, and to infiltrate important parts. Secondly, these growths, especially if rapid, tend to creep down into the anterior mediastinum,* behind the sternum. Thirdly, in addition to these dangers, there must be considered that of glandular invasion—*e.g.*, cervical, mediastinal, bronchial—and the doubtfulness of getting all the growth away, and the increased risks of hæmorrhage and cellulitis.

Mr. Sydney Jones and Mr. Battle have published (*St. Thomas's Hosp. Rep.*, vol. xvii. p. 232) an interesting case of sarcoma of the thyroid. The malignancy probably supervened upon previous ordinary enlargement of the gland. It was operated on repeatedly; on the first occasion very extensively, one sterno-mastoid being divided, July 16, 1887. A second operation, November 2, found both the sheath of the carotid and the œsophagus involved. Two months later, tracheotomy was required owing to fresh recurrence. Two further operations were performed in the next three months, and the tracheotomy-tube now not proving long enough, the useful device of securing a piece of large drainage-tube to a full-sized Durham's cannula made the patient comfortable. A little later, April 5, 1888, severe hæmorrhage took place from the common carotid, and two ligatures were applied above and below an opening in this vessel. The patient sank two days later, some dyspnœa having returned at the last. Notwithstanding the rapid recurrence, life was prolonged with comfort by the repeated operations for some months. In the fact that "the local malignancy was great, the general malignancy *nil*," this case of sarcoma contrasts strongly with the much more common carcinoma.

Dr. Rotter (*Arch. f. klin. Chir.*, Bd. xxxi. Heft 4; *Year-Book of Treatment*, 1885, p. 138) gives details of fifty cases of cancer of the thyroid submitted to operation. Of these eight died in the first twenty-four hours, five at the end of the first week, and eight at the end of the second week. Only four patients remained free from a recurrence at the end of six months. These figures point very strongly to the conclusion that in malignant disease of the thyroid attempted removal is most rarely justifiable.

Mr. Butlin (*Operat. Treat. of Malig. Dis.*, p. 206) thinks that "at present the number of instances in which a cure of the disease can be claimed is so small† that the operation is scarcely justified." The following facts, to which Mr. Butlin draws attention, are worthy of careful notice: (1) The large number of cases in which secondary affection was discovered at the necropsy, even when death occurred within a few days after the operation; (2) The frequency with which it was found impossible to entirely remove the tumour; (3) The difficulty of diagnosis in the early stage of malignant disease of the thyroid. The chief points which should be looked to here are early fixity and irregularity of outline, to which Mr. Butlin, quoting from Rose, adds continuous growth* and marked dysphagia.

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* A remarkable instance of malignant bronchocele is figured by Billroth (*Clin. Surg.*, pl. ii. and iii.). It was a soft carcinoma, and extended down behind the sternum, compressing the right innominate vein, and causing enormous dilatation of the superficial veins of the neck and front of the trunk.

† He thus analyses the cases in the paper by Dr. Rotter, quoted above, and two others by Dr. Rose and Dr. Braun (Langenbeck's *Arch.*, 1879, 1883). Of fifty cases submitted to operation, thirty were fatal. Of the twenty which survived the operation, a recurrence took place in ten, which was either fatal or promised rapidly to be so. In two the operation was abandoned. In three the further history was not known, and in one it only extended to a period of two months after the operation. In four only was a result, which Mr. Butlin courteously calls favourable, obtained. One, a patient of Bircher's, was well eleven months after operation; in the second, Bruns removed some enlarged glands a year after the first operation, and two and a quarter years later the patient died of inflammation of the lungs; the third, a patient of Maas's, was reported to be

Treatment of an Enlarged Thyroid by Ligature of the Arteries.—This operation was performed in thirty-one known cases (Wölfler, *loc. infra cit.*), but was given up, (1) from deaths due to wound-treatment of former days, (2) from imperfect results, as the inferior thyroid was never ligatured at the same time.

Prof. Wölfler,† now of Graz, considering that the various methods of treating goître are still open to objections, has lately advocated a trial of the above method.

In October 1885, he made use of it in a patient aged 29, who had much dyspnœa, for a rather large colloid thyroid. The right half being somewhat the larger, both the thyroid arteries were tied on this side, and also the median thyroid vein. The patient was discharged nine days later, the dyspnœa being considerably relieved and gradually subsiding completely. The neck, however, did not diminish in size at the same rate. A week after the operation the median circumference had diminished 1 cm., and seven months later 6 cm., when the right side of the goître had shrunk to one-half its former size; the left side had diminished somewhat.

Prof. Wölfler, from his later experience,‡ shows (1) that considerable shrinking, with marked relief to the dyspnœa, should follow this method, if successful, in a few days, and that there should be no recurrence. (2) Splendid results are here opposed by utter failures. If in the latter cases all the four arteries have been tied, abnormal vessels have perhaps existed. On this point he quotes Billroth as to whether the atrophy will be permanent: "If all four arteries have been tied, *yes*; if the circulation is re-established either through one of the principal arteries or through the vasa vasorum, *no*." (3) Experience has shown that ligature of all the four arteries is not followed by gangrene of the thyroid.

A further trial of this method is justifiable in any vascular and rapidly growing bronchoceles, especially if inclining to gelatinous consistency. Other indications are those rare cases in which an especial danger is present from paralysis of one vocal cord, or where extirpation

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quite well nearly four years after the operation; and the fourth, under the same surgeon, died in twelve months, of some uncertain lung affection.

* Dr. Rose has pointed out that the surgeon is liable to be deceived on this point by the effects of remedies. Thus, potassium iodide may cause a diminution in the size of the neck—a fact which may be attributed to the effect of the drug on the general enlargement of the gland, which is frequently associated with the occurrence of more or less limited malignant disease. Attention has already been drawn, at p. 450 of this book, to the procrastination (sometimes pernicious in its results) which this temporary result of giving potassium iodide may bring about in malignant disease.

† *Wien. Med. Woch.*, 1886, Nos. 29 and 30; *Ann. of Surg.*, Dec. 1886, p. 523.

‡ In his monograph on the Surgical Treatment of Goître (*loc. supra cit.*), p. 438.

of one half is thought unadvisable on account of the age or some special point in the condition of the patient.

These vessels vary so much in situation and course, according to the size and growth of the bronchoceles in different directions, that any dissections for finding them must be uncertain. The chief points to bear in mind are the upper and lower parts of the enlarged lobe: the superior thyroid artery is often rendered superficial by the upper limit of the tumour raising it up. Both vessels may be enlarged and somewhat softened, and thus secondary hæmorrhage may readily occur unless the wound is kept sterile.

Ligature of the Superior Thyroid Artery.

RELATIONS. This vessel, the first branch of the external carotid, arises just above the bifurcation, about a quarter of an inch below the great cornu of the hyoid. At first, covered only by thin fasciæ and the platysma, it ascends slightly, and then curves downwards with a tortuous course, covered by the depressors of the hyoid bone and the sterno-thyroid.

Operation. The patient's head being suitably raised, and turned to the opposite side, an incision, about two inches long, is made along the inner border of the sterno-mastoid, with its centre corresponding to the upper border of the thyroid cartilage. The superficial parts being divided, the sterno-mastoid and the large vessels are drawn outwards, and the omo-hyoid downwards and inwards, or else tied and divided. The artery is then searched for with the point of a steel director in the hollow between the larynx and the carotid. Some enlarged veins, belonging to the superior thyroid, will probably require division after the application of double chromic gut ligatures.

Ligature of the Inferior Thyroid Artery.—This operation is a good deal more difficult, owing to the depth of the vessel and its more important relations.

RELATIONS.—The artery, the largest branch of the thyroid axis, ascends tortuously inwards behind the carotid sheath, the middle cervical ganglion and its branches lying in front of it. Before entering the gland it lies for a little distance in relation with its posterior surface, and in this part of its course the recurrent laryngeal is in close contact with it.[*]

GUIDE.—The carotid tubercle of Chassaignac, or the transverse process of the sixth cervical vertebra. Sir W. Mac Cormac gives the body of the fifth cervical vertebra, opposite to which the artery enters the thyroid gland. The common carotid is also a guide.

Operation. An incision, three inches long, having been made along the anterior border of the sterno-mastoid coming down to the clavicle as if for ligature of the carotid low down, the deep fascia is opened and the sterno-mastoid and the structures in the carotid sheath drawn outwards. The head being now flexed to relax the parts, the carotid tubercle is felt for, and the artery sought for below it, by carefully working here with a director. The vessel should be exposed and the ligature applied* as close to the carotid as possible, and thus at some distance from the thyroid gland, so as to avoid injury to the recurrent laryngeal, which, as above stated, crosses over the trunk or ascends among the branches of the inferior thyroid. The neighbourhood of other important structures—*e.g.*, the phrenic nerve—must be remembered.

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[*] Sir W. Mac Cormac (*Lig. of Arteries*, p. 71) says that the nerve often passes between the terminal branches of the artery. He reminds the operator that the left artery is in close contact with the œsophagus, and that the thoracic duct, at first posterior, arches over the artery on this side to enter the left subclavian vein.

Treatment of Thyroid Cysts (Fig. 213).—These are sometimes of much importance owing to their size, their important relations, and, as shown by Mr. Clutton's case below, their occasional vascularity.

The best treatment is antiseptic excision whenever this is practicable; with much larger and older ones, a safer one may be antiseptic incision and drainage. Injection with iron perchloride has given some good results, but there is always the risk of suppuration and cellulitis in a very dangerous region owing to the presence of the larynx above, the mediastinum below, and of numerous veins, these being liable to puncture, and thus to immediately fatal thrombosis, or, later on, to septic phlebitis.

Where the cyst is moderate in size and not of very long duration, it should always be excised; and the case given below shows that this may sometimes be practised where the cyst is huge in size and of long duration. The cyst, if not previously submitted to futile blistering, &c., usually turns out easily. If it will give more room the cyst may be slit up, and its contents evacuated, when, by seizing first one cut edge and then the other, it is turned out in a collapsed and empty state. In either case, great care must be taken to work with a pair of blunt-pointed curved scissors (p. 539). After removal of cysts of any size the remains of the thyroid lobe from which the cyst is shelled out looks collapsed and useless. It should not be removed, however. The wound cavity should be obliterated by carefully applied pressure (p. 542). Where much thyroid substance is left lacerated, it would be well to fill the wound for a few days with dry sterilised gauze (pp. 532, 542).

The above remarks apply to single cysts. Mr. Clutton (*St. Thomas's Hosp. Rep.*, vol. xvi. p. 173) has pointed out that where there are many cysts, or where a cyst is combined with much disease, the whole half of the thyroid affected had better be removed.

Where excision is impossible—a rare condition—the method of incision is usually very simple. The soft parts having been duly cleansed, an incision is made through them down to the cyst, and any bleeding points secured. The cyst is then slit open and its interior examined. This may vary considerably both as to thickness and contents, and vascularity of lining membrane. Thus the contents may be a serous, mucoid, gelatinous, or grumous material, or coagulated blood-clot. The amount of vascularity is of two-fold importance: if of very long standing the cyst-wall may be so fibrous and evascular that sloughing of it may readily take place, especially if the wound becomes septic. On the other hand, it may be extremely vascular (Clutton, *loc. supra cit.*), in which case such abundant hæmorrhage will take place as to leave no time for suturing, and require immediate plugging with aseptic gauze.

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* According to Billroth and Wölfler this artery is often friable, and thus easily torn, this condition being perhaps due to fatty degeneration from pressure of the bronchocele.

Knowing how tedious these cases are in granulating from the bottom and becoming completely obliterated, I prefer, in the few cases where excision is impossible, to suture the cut edge of the cyst to the surrounding margin of the skin, and then, with a sharp spoon, to curette the lining membrane, thus promoting the closing of the cavity from the bottom. The cavity is then lightly plugged with strips of sterilised gauze, and the dressings applied. But this method, by failing to secure primary union, is much more tedious than that of excision.

I would again draw attention to the very important fact that in these, as in all other thyroid cases (and in many others) where primary union is not secured, silk ligatures or buried sutures, if many of these have been used, may continue to come away for a very prolonged period. The cyst quickly falls in and puckers together, but a sinus is liable to persist through which ligatures are long discharged. Thus, in one of Mr. Clutton's cases a sinus persisted for two years, and then quickly closed; in another the patient was still wearing a drainage-tube a year after the operation. And in the case of mine now mentioned, it was not till nine months after the operation that the last ligature came away, and the wound soundly closed.*

As bearing on the treatment of thyroid cysts by excision, and as a good example of one of the complications which may follow operations on the thyroid gland, I may now mention the following case (Fig. 213):

A gentleman, aged 55, was sent to me, towards the close of 1885, by Mr. Cooper Forster, with a right-sided thyroid cyst, almost colossal in size, and reaching from the ear to below the clavicle, and outwards into the posterior triangle. The trachea was under the edge of the left sterno-mastoid. The swelling was first noticed twenty-six years before, being then about the size of a hazel-nut. About nineteen years before, owing to some dyspnœa, the swelling was tapped by Mr. Forster; gradually refilling and increasing in size, it was tapped by myself in 1885, the fluid being thick with material resembling Parmesan cheese. As the cyst quickly refilled, I proposed free incision and drainage, and sought first the opinion of my colleague, Mr. Durham. As, in spite of twenty-six years' history, the cyst had a certain distinct, though limited, amount of mobility, Mr. Durham advised extirpation in preference to incision. This counsel I accordingly followed. Ether was taken very badly, especially at first. An incision being made from the angle of the jaw to the right sterno-clavicular articulation, the sterno-mastoid was found spread out over the cyst and adherent to it, perhaps from the previous tappings. As the patient was breathing very badly, no time was spent in separating the muscle, but the cyst was reached by cutting away the adherent part. The superior thyroid vessels being found and tied, the cyst was turned downwards out of its bed, partly with the finger, partly with a blunt dissector; a vessel in the position of the middle thyroid vein was found, and a small vessel below where the inferior thyroid was expected. The chief attachment of the cyst was in the middle line, where it was connected with the isthmus (not itself enlarged) by a fairly fleshy pedicle. This was separated from the trachea and tied in three pieces, partly with the aid of a steel director, partly with an aneurysm-needle. About fourteen carbolised silk ligatures were used, and strict antiseptic precautions were taken throughout, including the use of the spray. An enormous cavity remained when the cyst was shelled out, exposing the common carotid and its bifurcation, the larynx and trachea; but, though a strong light was thrown into the bottom with a mirror, nothing could be seen of the œsophagus or recurrent laryngeal. Special care was taken to verify this, as towards the close of the operation (which lasted twenty-five minutes) there was some vomiting of coffee-grounds stuff, streaked here and there with brightish blood.

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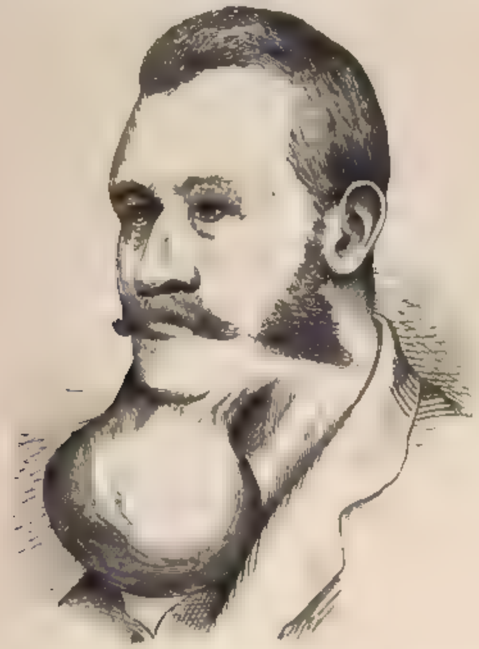
* In this case (it is fifteen years ago) plaited-twist silk (Turner's) was used. This is so closely interwoven as to resist changes in the tissues and absorption most obstinately. It should never be employed. Ordinary silk of appropriate thickness is much to be preferred, being equally safe and of a much more open texture.

No dyspnœa and no lividity had been noticed during the operation, beyond the difficulty which had from the first accompanied the anæsthetic. As the effects of the ether subsided, a peculiar stridor was found to accompany the breathing, being much more marked in inspiration. The voice was not affected, beyond being weak, and there was no lividity. The stridor, but without marked dyspnœa, went on increasing for about two hours, the patient being much alarmed from dreaded "choking." Though he vowed that he could not swallow owing to the above alarm and from the feeling of soreness, "like a bone in the throat," he was persuaded to take a dose of potassium bromide, and passed a fairly good night. The next day was a comfortable one, and the breathing, which was twenty in the minute, was much easier, and perfectly so while the patient slept. The next two days were very anxious ones, the stridor returning, with great restlessness and distress on account of paroxysmal attacks of dyspnœa. Accompanying these a condition of quiet delirium set in. The respirations ran up to 40, the pulse to 140, while the temperature remained 99°. The wound was now, and throughout, perfectly sweet. As there was some carboluria (without albumen) the drainage-tubes were syringed out with boracic acid, and iodoform gauze dressings applied as before. The pulse was of grave omen, about every ten or twelve beats dropping, fluttering, and then, as it were, staggering on, to intermit again in another ten beats. This, Dr. Goodhart thought, might be due to some chloral that had been given at night.

FIG. 213.



The diagnosis now was doubtful—whether one of injury to the recurrent laryngeal, or one of œdema glottidis. Mr. Durham, who inclined to the latter view, advised the use of warm, moist boracic acid lint dressings, and inhalations of steam and terebene.

The breathing gradually became less laborious and noisy, and the power of swallowing quickly returned. Recovery was retarded by a succession of fogs and some localised pneumonia, which, giving anxiety at first, entirely cleared up under Dr. Goodhart's hands. When the patient left town, six weeks after the operation, there was no difficulty in swallowing, the stridor was only noticed on deep respiration, or during quick or prolonged talking. The wound was now represented by a sinus at the lower end; all the rest was well healed. The failure to secure primary union was largely due to the great restlessness of the patient two days after the operation. Ligatures continued to come away for nine months, when the wound healed at once. When the patient was last seen, four years after the operation, there was still a very little stridor* on deep breathing or rapid talking, and the voice was still a little husky, but the patient was able to follow his employment actively, and to get quickly over hilly ground.†

While the diagnosis here remains obscure,‡ I am of opinion that (1) the restlessness and distress were due to absorption of thyroid secretion (pp. 532, 542); (2) that, with the bloody vomit in the course of the operation, and the great dysphagia afterwards, although the huge cyst turned out so quickly, some slight injury was probably inflicted on the œsophagus, with stretching or embedding in inflammatory effusion of the right recurrent laryngeal. Whether this be correct or not, I think, with all proper deference to Mr. Durham's opinion, that this case shows that, in cases of thyroid cysts, when large or of long standing, incision with antiseptic precautions is preferable to excision.

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* The stridor here and in other cases where certainly no damage has been done to the recurrent laryngeal nerve may have been due, in the first place, to the altered relations and want of support of the much displaced trachea; its long continuance, in a very minor degree, to contraction of the scar tissue.

† A year after the operation he wrote thus: "I have not been so strong and active for many years. The other day I went in the morning to London, to the Academy, Grosvenor, 'Alice in Wonderland,' Fitzroy House, then to a council meeting of the Photographic Society, and home. There was a damp fog all day, and I am not the worse for it."

‡ Owing to a projection of the incisor teeth, and a life-long difficulty in opening the mouth widely, it was found impossible—Mr. Durham and Dr. Goodhart also trying—to get a view of this patient's larynx.

CHAPTER XIV.

REMOVAL OF LARGE DEEP-SEATED GROWTHS IN THE NECK.

BEFORE deciding to undertake the removal of one of these, the surgeon should consider carefully the following points:

A. **The nature and surroundings of the growth.**

B. **His operative skill in these cases, and his knowledge of anatomy.**

C. **His experience in aseptic surgery and in keeping a large wound sterile.**

The chief growths which call for a decision are the following: The (rarely met with) more innocent ones—*e.g.*, the enchondroma of Prof. Spence,[*] the fibrous tumour of Mr. Butcher,[†] glandular tumours, including the more simple tubercular glands when they do not yield to other treatment; sarcomata, very likely cystic, originating in the neck apart from the cervical glands; sarcomata of the glands; and carcinomata of the glands secondary to epithelioma of the tongue, lip, &c.

Of the three points above mentioned, it will only be needful to consider separately the first; the importance of the two others will be sufficiently shown in the remarks on the operation and after-treatment.

A. **The Nature and Surroundings of the Growth.**[‡]—In examining into these, careful attention should be paid to the following: *Duration; Rate of increase; Amount of fixity.* How far this last was early established, and how far it is absolute, are of the utmost importance. The gravest cause of fixity is, of course, a growth with a wide base, or numerous root-like processes extending into important parts. The fixity should be tested by seeing how far the finger-tips can be insinuated beneath the growth, how far it can be lifted up, and the amount of its connection to parts such as the jaw and larynx, the head being steadied by an assistant while the growth is lifted up and its deep processes put on the stretch as much as possible. *The outline:* Is this well marked or indistinct, and, if the latter, is it in dangerous regions, such as the parotid, the zygomatic, and other fossæ, that the growth is lost? *Its relation to important structures, and the degree to which it blends with them:* Thus, any evidence of pressure on vessels and nerves, trachea and pharynx, &c., should be carefully looked for—*e.g.*, weakness of the temporal pulse, engorgement of veins above, alteration of pupil, numbness of upper limb, dyspnœa, or dysphagia. Does the growth dip near or into the thorax? How far under the sterno-mastoid does it go? Are the glands enlarged as well? Is the skin involved? This last point, together with fixity, indistinctness of outline, rapid growth, softness, and fusion with surrounding parts, is of chief importance, and if co-existing to any extent, will usually put any operation out of the question.

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[*] Growths of the tonsil are considered at p. 469; bronchocele at p. 524.

[†] This case, in which the growth weighed over 7 lbs., is related in the *Dub. Journ. Med. Sci.*, Nov. 1863. Mr. Butcher's case will be found amongst his *Operative Surgery Essays*, p. 809. The reader should also consult Mr. Holmes's remarks on these cases (*Syst. of Surg.*, vol. viii. p. 886), a paper by Mr. Barker (*Lancet*, 1886, vol. i. p. 194), and one by Mr. Jessett, illustrated by some admirable photographs (*Brit. Med. Journ.*, 1886, vol. ii. p. 712).

[‡] Mr. Holmes (*loc. supra cit.*) quotes Langenbeck (*Arch. f. klin. Chir.*, Bd. i. Heft 4, S. 14) as pointing out that, in tumours which involve the sheath of the vessels, engorgement of the veins of the face is rarely absent. In one case he observed this venous engorgement to be on the opposite side to the tumour. This he attributed to the fact that the tumour compressed the carotid artery as well as the jugular vein, as proved by the weakness of the temporal pulse.

Even when the surgeon is doubtful as to the advisability of meddling with one of these growths, he may decide to make an attempt under such circumstances as the following, even if it end in failure: When the patient's life is rendered worthless by the present wretchedness and approaching dangers of the growth, especially if he be young, as in the words of Mr. Butcher (*loc. supra cit.*, p. 871):

> Though the boy did not suffer pain, yet his life was rendered very miserable: the weight ever tending to depress the head, occasioning persistent fatigue and even pain in the muscles of the neck, and so compelling the patient often to adopt the recumbent position, the bulk thrusting up the head, embarrassing every movement, almost preventing any change of position; the pressure impeding respiration, often obstructing it during sleep so as momentarily to threaten suffocation, making the patient start from his bed in terror and alarm, unrelenting or enforcing one attitude during sleep, with difficulty in deglutition, except under extreme watchfulness in adopting position.

So, too, in some cases of cancerous glands, associated with epithelioma, *e.g.*, of the tongue, the surgeon may justifiably perform an extensive operation in the hope of removing both the primary and secondary epithelioma, or, after a successful removal of the tongue, operate on the infected glands widely and deeply to give the patient another prolongation of life. In such cases it should be the patient who urges the operation after all the risks have been placed before him.

Main Points in the Operation itself.

1. **Free Exposure of the Growth.**—The incisions should be sufficient, the flaps turned back, **V**, **Γ**, or **X** in shape. Thus, if the growth be in the anterior triangle, not encroaching on the posterior, a **V**-shaped flap with the base upwards, one limb along the sterno-mastoid and the apex above the sternum, may be employed; or one **Γ** in shape, the long limb inside the above-mentioned muscle, and one at right angles to it under the jaw. If the growth invade both triangles, and it be necessary to divide the sterno-mastoid, an incision obliquely across both triangles, and over the muscle, from mastoid process to sternum, and then a second to make it crucial, will be the best. It is always to be remembered that inadequate exposure of the tumour will lead to groping in the dark, bruising of the soft parts, and injury to important structures.

ii. **Deeper Dissection.**—In this attention must be paid to—

(*a*) Working as much as possible with a blunt dissector, a steel director, or the finger, or using blunt-pointed scissors partly to cut with and partly closed as a blunt dissector, and keeping the instrument used close to the growth. The dissection should be begun, as a rule, where the growth is most free, and where its relations are not important.

(*β*) Clamping or tying with sterilised ligatures every vessel before it is divided, not only to minimise the loss of blood, but also to avoid the risk of air entering the veins, especially low down in the neck.

(*γ*) Structures, hitherto thought too important, may be divided, if really needful. Thus, not only the sterno-hyoid and omo-hyoid should be divided, but the sterno-mastoid also. Of the structures in the carotid sheath, the internal jugular is, as pointed out by Mr. Holmes, the most likely to be implicated. It may be divided without hesitation after it is secured with two catgut ligatures.*

In the autumn of 1887, while operating for Mr. Cooper Forster, I tore through the internal jugular vein in removing some epitheliomatous glands: the hæmorrhage was for a moment very profuse, but yielded to sponge-pressure. Catgut ligatures were applied to the two halves of the vein, and the patient recovered. In a similar operation the lingual vein was separated so close to the internal jugular as to leave little more than a rounded opening. In preference to tying the vein above and below, I left a pair of Spencer Wells's forceps on for three days. Recovery took place. In a similar case met with more recently, finger-pressure made above the wound in the internal jugular rendered the vein so flaccid that I was able to tie up the opening securely.

The common carotid and even the vagus have been divided, and without a fatal result. On two occasions in 1894, during the removal of epitheliomatous glands in the neck, I tied all three carotids and removed part of the vagus, and in one case the sympathetic (superior ganglion). In both the disease was secondary to cancer of the tongue, and in each case the mouth remained sound. In the first, in which, in addition to ligature of the carotids, a portion of the vagus and the superior cervical ganglion were taken away, I had removed, four months before, the tongue, floor of the mouth, and symphysis. The patient again recovered, and was alive and well three months later, though local recurrence behind the jaw is certain. In the second case I had removed two-thirds of the tongue three years before, and the patient had been able to keep his place as gamekeeper. He was 57, and the ligature of the three carotids proved rapidly fatal. When the insensibility of the anæsthesia should have passed away, the patient could not be roused; he gradually sank into coma, and died within forty-eight hours. Acute cerebral softening was found in the course of the middle cerebral artery.

In a deep dissection the presence of some other structures must be remembered.†

Mr. Godlee (*Clin. Soc. Trans.*, vol. xix. p. 321) showed a child in whom, during the removal of a deep-seated growth, the nature of which was doubtful and which was pressing upon the pharynx, the cervical sympathetic had been wounded. The only

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[*] Mr. Barker (*Lancet*, 1886, vol. i. p. 194) records a case, probably a cystic sarcoma, in which $1\frac{1}{2}$ inch of this vein and part of the scalenus anticus were involved in the growth and removed. The case did well.

[†] In the posterior triangle, growths springing from the lower vertebræ or the first rib may involve the cords of the brachial plexus, causing much pain and requiring very tedious dissection for their removal. Such a case was brought before the Medico-Chirurgical Society, January 12, 1886, by Dr. Bruce and Mr. Bellamy.

results were, that the pupil on that side was smaller but not stationary, and that the ocular slit was also smaller.

In 1870 I saw the thoracic duct opened in an operation for the removal of enlarged glands on the left side. Chyle escaped deep down in the wound, and the case soon ended fatally.

Prof. Keen has published four cases of injury to the thoracic duct during operations. Three of these recovered; one was a case of his own, in which the injury took place during a difficult dissection for the removal of matted tubercular glands lying above the left clavicle.

(δ) If possible, the growth-capsule, which is often soft and delicate, must not be ruptured. On examining the growth after removal, the capsule should not only be entire, but any process should be blunt and rounded, not soft and ragged as if torn away from parts left behind.

If the surgeon feel doubtful as to any portion being left, as in the fossæ about the base of the skull, he should use a sharp spoon and Paquelin's cautery, or pack in lint with a paste of equal parts of zinc chloride and flour (p. 339), or, better perhaps, use formalin.

(ε) Throughout these operations, which may necessarily be prolonged and attended with loss of blood, and in which important parts may be disturbed and pulled upon, the surgeon should keep himself informed as to the effects of the anæsthetic.

iii. **Closure of the Wound and Application of Dressings.**—After completely removing the growth and any outlying glands, the resulting cavities are thoroughly dried out, and drainage provided in accordance with the position which the patient will occupy. Tubes of sufficient size being in position, the wound is brought together and the dressings applied with the precautions already given at p. 542.

Operative Treatment of Tuberculous Glands.—This may be given here owing to the greater frequency and importance of this disease in the neck. *Question of Operative Interference.*—The following abundantly justify something more vigorous than mere palliative treatment: (1) The fact that one gland has power to infect others, even when the local starting-point may have been cured, though too late to prevent extension. (2) The disease, if merely palliated, is often extremely tedious, keeping the patient from the enjoyment and activity of some of the best years of life. (3) The scars which follow on a natural cure are far more disfiguring and extensive than those after a well-planned operation, especially one in which primary union has been secured by strict aseptic precautions, and by operating before caseation and suppuration have altered the normal condition of the parts. (4) The long years a natural cure requires; the repeated suppurations and the blighted days cause grave deterioration of the general health, which may persist for life, long after local cure has taken place. (5) The poor vitality thus induced, and the actual presence of the tubercle bacillus, render the patient very liable to such diseases as phthisis. (6) The chief indication for operation is persistence of the disease, and the slightest evidence of commencing caseation. (7) There are a few and very occasional cases in which operation is to be deferred or avoided. I refer to those where (*a*) there is advanced disease elsewhere, and (*β*) where there is threatening of a general outbreak. Here the temperature will be a valuable guide. (8) In advising operative steps in tubercular glands of the neck, any thoroughly qualified surgeon is justified in impressing on the friends (*a*) that the treatment of the case will be shortened; (β) that convalescence will be hastened; (γ) the result will be more permanent; (δ) if it be performed early, less of an operation will be required.

The most useful methods are—(A) Excision; (B) Curetting or scooping out the glands.

(A) **Excision.**—*General Principles to be Remembered.*—i. Antedate, if possible, caseation and suppuration. If these have been allowed to run on before an operation is permitted, the parts will be matted, adherent, altered; relations will be difficult, perhaps impossible, to make out; important structures, such as the internal jugular vein, will easily be damaged; primary union will be rarely secured, and the scar will, therefore, be needlessly prominent. ii. Place the incision, whenever possible, in some sulcus where, later on, it will be but little noticeable. iii. Always make a free and sufficient incision. The scar will be no larger, and much handling through a small incision forbids primary union. A free incision enables the operator, in cases where caseation has already taken place, to find one or more spots where the structures are normal, and where he can start with important relations, *e.g.*, the internal jugular vein, easily recognised. iv. Treat tubercular mischief, here as elsewhere, as if it were malignant, and eradicate all diseased tissues; deal with it, moreover, as if this, the first opportunity, were going to be the last. v. Maintain careful asepsis throughout. vi. Whenever in doubt employ drainage. Thus a tube should always be employed in cases where a caseating gland has ruptured during removal, and may have infected the wound in spite of careful swabbing out with pure carbolic acid and irrigation. Again, where the cavity is a large one, of uneven base, with many pockets or recesses, where much oozing is present, a drainage-tube should be employed for two or three days. vii. Pressure is always to be well applied, for the same reasons and in the same way as given at p. 542. viii. Sufficient rest of the parts is most essential here. Mr. Treves has insisted on this point in the after-treatment. It is one of very great importance, if a small and sound scar, and obliteration of any tubercular material possibly left behind, are to be secured. Poroplastic jackets holding up efficiently the chin and occiput are the best. When the parts are thus kept at rest, the child should live out of doors in the best air available. ix. The patient is to be kept for a long time under observation, owing to the risk of persistence and reappearance of the disease.

I have above referred to some main points in the operation for excision of tubercular cervical glands; there is one more to which I would allude. It has been recommended by good surgeons to remove, between double ligatures, the internal jugular vein on the side where it lies embedded in the tubercular glandulæ concatenatæ. While I admit the force of the argument brought forward by Mr. Stiles and others, that this removal of the vein, while safe at the time, greatly facilitates the extirpation of the tubercular glands, I hope that none of my readers will think that this step is one to be lightly undertaken, still less that it is to be adopted as a matter of routine, as one of the improvements in modern surgery. It is well known by those who have seen much of these cases in children's hospitals, that it is not very unusual for tubercular cervical glands to be bilateral. Let us suppose that the internal jugular has been resected on one side. A few years later, like mis opposite side, and a surgeon holding advanced views ties the internal jugular on this side also. The effect of this on the cranial circulation of the child might be instructive—it would scarcely be harmless.

(B) *Curetting or Scooping out the Glands.*—While its value has been clearly proved in the instructive papers on "Scrofulous Neck and the Surgery of Scrofulous Glands," put forth by Dr. Allbutt and Mr. Teale as clinical lectures at the Leeds School, from which so much good surgery has already come, it is very inferior to aseptic treatment by excision, for the reasons I give below. The following are Mr. Teale's conclusions as to the surgical treatment of these cases:—(1) That surgery can secure the healing in a very few weeks* of gland cavities and sinuses, even though they have existed for years. (2) That, in dealing with sinuses, gland abscesses, and decayed or semi-decayed lymphatic glands, the action of the surgeon must be vigorous and thorough. (3) That the visible abscess, which would often be called, and treated as, a tuberculous suppurating gland, is, as a rule, merely a subcutaneous reservoir of pus, its source, a degenerate gland, being *not subcutaneous*, but *sub-fascial*, *i.e.*, under the deep cervical fascia, and sometimes even sub-muscular, the communication between the two being a small opening just large enough to admit a probe or director. (4) That it is utterly futile merely to incise or puncture such a subcutaneous abscess dependent upon a degenerate gland which lies beneath the deep fascia. (5) That when a damaged or suppurating gland has been got rid of before the overlying skin is thinned by advancing suppuration, the resulting scar is insignificant and not an eyesore. (6) That, in dealing with a sinus, the channel should be enlarged by the knife or a "Bigelow's dilator," and the whole of its granulating surface scraped out. Where the skin is thin and blue, this should be scraped away, and any cutaneous overhanging edges trimmed off with scissors. (7) That, in dealing with a sinus or an abscess, the surgeon should not rest content until he has discovered and eradicated the gland, always remembering that, if it be not obvious, there is sure to be a small track leading to it through the deep fascia. This should be enlarged so as to admit a sharp spoon. (8) That, when a gland has suppurated or become caseous, the capsule should be freely opened and the contents scraped out. This is sometimes easy, the enucleation leaving the stiff capsular case virtually cleaned out. Sometimes it is very difficult to get rid, even by the most vigorous scraping, of a tough living stump of gland firmly adherent to the capsule. It is well to dissect this remnant away with a scalpel, if the risk of injuring important structures be not too great. (9) That sometimes, when such an empty capsule is left, the finger detects in its wall a bulging contiguous gland. This should be punctured through the wall of the cavity, and so reached and enucleated. In this way, in more than one instance, Mr. Teale has emptied from one external opening a group of three or four glands, suppurating or broken down.

I consider the above method much inferior to that of aseptic excision, for the following reasons:—(*a*) It is limited to cases where one or two glands are involved. Cases such as these form a small minority of tubercular cervical glands. (β) It deals only with caseating and suppurating glands. (γ) In the majority of cases there are glands, often numerous, which are infected and which will certainly give trouble, though not as yet softened. Such can only be removed by a sufficient incision and dissection. (δ) It is an operation in the dark. This is an objection of great weight when the gland lies deeply and may be attached to important structures, *e.g.*, the internal jugular. (ε) This operation is much more likely to call for repetition than a well-planned aseptic excision on lines widely, carefully, and thoroughly carried out.

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* In severe cases several operations—three or more—will be needed. After the first one or two the general condition is said to rapidly improve.

CHAPTER XV.

OPERATIONS ON THE ŒSOPHAGUS.

ŒSOPHAGOTOMY, ŒSOPHAGOSTOMY, ŒSOPHAGECTOMY.

ŒSOPHAGOTOMY.

Indications.—This is required for such foreign bodies—*e.g.*, tooth-plates, bones, coins—as have resisted careful, justifiable attempts at extraction: bodies which are certain, if left, to lead to grave results—*e.g.*, hæmorrhage, sloughing, deep cervical suppuration, &c.

It will be wise to proceed to an early operation, and thus avoid the risks of a fatal result from those conditions given at p. 565. In making up his mind to submit his patient to an operation, the surgeon must weigh the size and character of the body, the time it has been swallowed, the urgency of the symptoms—*e.g.*, dysphagia, dyspnœa from pressure on the larynx, emphysema,* œdema, &c.—and whether the attempts already made at extraction have been all that are justifiable, and whether the instruments at hand have been appropriate.

A few words as to the localisation of the foreign body, especially when this is low down, may be helpful here. It must always be remembered that the precise site of the foreign body is not always marked by any external swelling or resistance, nor by accurately referred pain; furthermore, bougies occasionally give very slight indications of the presence of bodies (even rough ones) in the œsophagus or pharynx. The Röntgen rays have been of much service here.

Thus, Mr. Haslam (*Brit. Med. Journ.*, 1898, vol. i. p. 375) recorded the cases of two children, one aged 5, in which a skiagram showed a halfpenny in the œsophagus at the level of the sternal end of the second rib, the coin having been swallowed four months previously. In the other, aged 3, who had swallowed a halfpenny ten days before admission, the coin was clearly seen just below the upper end of the sternum. In each case the coin was removed by the coin-catcher at the first attempt.

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* In a case where emphysema already exists with an impacted foreign body it will be wiser to open the œsophagus at once, and not make attempts at extraction. Dr. Church (*St. Barthol. Hosp. Rep.*, vol. xix. p. 55) gives a case in which swelling of the neck began three hours after the tooth-plate had been swallowed. The next day, after several attempts with a horsehair probang, the plate, which lay midway between the larynx and the sternum, was brought up into the reach of forceps and extracted by Sir W. Savory. Death took place two days later, there being perforation of the end of the pharynx, with suppuration in the neck, mediastina, and left pleura.

Operation.—The head being somewhat extended and turned to the right* side, the skin of the neck sterilised, the surgeon makes an incision three inches long from just above the thyroid cartilage to within half an inch of the sterno-clavicular joint,† a little in front of the anterior border of the sterno-mastoid. Skin and fasciæ being divided,‡ the cellular tissue in front of the above-mentioned muscle is opened up with a director, and the pulsation of the artery and the bodies of the cervical vertebræ, fifth and sixth, felt for. The omo-hyoid may be drawn down, but it is best to divide this muscle at once, and, if it be needful to seek for the body low down in the neck, the sterno-hyoids and sterno-thyroids also. The sterno-mastoid and large vessels are now drawn outwards, and the trachea§ inwards, with retractors, the thyroid gland probably showing plainly on the inner side, and the internal jugular, if dilated, on the outer. The presence of the inferior thyroid behind the carotid sheath, and that of the recurrent laryngeal running up in the groove between the trachea and œsophagus, must be remembered. Throughout these steps of the operation the bleeding must be most carefully arrested, and the deeper part of the wound, with the important structures around it, kept quite dry.

If the foreign body cannot be felt projecting in the œsophagus—*e.g.*, behind the cricoid—the mouth should be opened with a gag, and a bougie or probang passed, as the flaccid tube walls are naturally in contact. When the œsophagus lies unusually deep, following round the thyroid or cricoid cartilage with the finger will find it.

When the site of the foreign body has been made out, or when, failing this, it is decided to open the œsophagus low down and to pass probes, &c., a clean incision must be made as far back as possible, so as to avoid the recurrent laryngeal filaments.‖

When the tube has been opened, and any bleeding from its walls arrested, the opening is dilated by dressing-forceps, by a probe-pointed bistoury, or by curved forceps passed from the mouth and expanded in the wound. Even after a free opening has been made it may be impossible to dislodge the body, if this, a tooth-plate, has projecting clips, or if it is tightly embraced by the contraction of the œsophageal fibres. In such a case the body should be (if a tooth-plate) divided with bone-forceps and removed in two portions, care being taken to keep hold of each portion with forceps (Lawson, *Clin. Soc. Trans.*, vol. xviii. p. 292).

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* The left side is preferable, as the œsophagus lies more to this side, and as operating on the left side allows of freer movement of the right hand, while the left is at liberty to move the larynx, &c.

† If the neck is very stout, or if the parts are swollen, &c., the incision may be from just below the angle of the jaw to close to the sternum.

‡ The anterior jugular vein may give trouble, and should be divided between two catgut ligatures.

§ The larynx should not only be drawn to the right, but tilted over to this side also, as this brings up the œsophagus.

‖ Mr. Cock (*Guy's Hosp. Rep.*, 1868, p. 3) draws attention to this point. Both his patients were in the habit of singing; in the first case (*ibid.*, 1858, p. 229) a fine tenor voice was replaced by a bass; in the second, in which the œsophagus was opened farther back, the voice did not suffer.

If, after exposing the œsophagus, the body cannot be felt—which will rarely happen,—metallic probes or soft bougies should be passed through the wound in the œsophagus, and the lower cervical and the upper thoracic portions of this tube carefully explored. The question may now be considered: How far down from the œsophagus can a body be extracted? The most accessible part is, no doubt, its junction with the pharynx, opposite to the cricoid cartilage, and the first two inches below this point. Mr. Cock (*loc. supra cit.*) writes: "It might even be possible to extract a foreign body from the early thoracic portion, provided it could be reached with the finger, and thus brought under the influence of a pair of curved forceps." *

As far as my knowledge goes, the lowest point from which a foreign body has been removed occurred in the practice of Mr. Bennet May.

Here a child, aged 7, had swallowed a halfpenny three and a half years before. The coin had ulcerated through the œsophagus and opened the right bronchus, lying partly in this and partly in the œsophagus. It was removed successfully by œsophagotomy.

When the foreign body has been removed, the question of introducing sutures into the œsophagus will arise. These should only be used when the wound in the gullet is clean-cut, not bruised, and when the body has been quickly removed; the sutures should be of fine chromic gut, and only the upper part of the wound in the œsophagus should be closed, the rest being left open to the bottom to allow of free drainage, owing to the danger of sloughing, pent-up foul secretions, and blood-poisoning (p. 565).† A drainage-tube should be inserted to the bottom of the wound, iodoform dusted in, a few sutures placed in the edges of the wound, dry dressings applied—viz., iodoform gauze, salicylic wool, &c. —if the wound has not been much probed about, and there is thus good reason to expect early union. But if ulceration of the soft parts has been found, if they are inflamed, emphysematous, &c., the wound should be left open, drained to the very bottom, and fomentations of hot creolin solution (1 or 2 per cent.) frequently applied.

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* The proximity of important parts to the thoracic portion of the œsophagus is well known. Thus, in *Path. Soc. Trans.*, vol. xix. p. 219, is recorded the case of a man who swallowed a bone which lodged in the œsophagus opposite to the arch of the aorta. Death took place suddenly on the fifth day from perforation of the aorta and hæmorrhage, after a slight exertion. Mr. Eve (*Clin. Soc. Trans.*, vol. xiii. p. 174) gives a case in which a fish-bone, impacted in the œsophagus, wounded the heart fatally. It was thought that the position of the fish-bone was perhaps due to previous use of the probang.

† If there is any doubt, sutures had far better be dispensed with. Dr. Barton (*Ann. of Surg.*, July 1887) has recorded a case of successful œsophagotomy in a little child—the age does not appear to be given. The foreign body, a small steel roller of a sewing-machine, had been swallowed three months before. This was extracted through a very small opening in the œsophagus, "after the manner of working a stud through a button-hole which is too small for it," from the fear of causing a fistula if the opening was enlarged. The wounds in the œsophagus and superjacent parts were separately sutured. Epileptic fits soon followed, and frequent vomiting tore open the wound. The fits having ceased with the administration of potassium bromide, the wound in the œsophagus was pared and sutures re-applied as before. This limited much the escape of fluids through the wound, but did not entirely stop it. The passage of a tube through the mouth twice a day caused so much irritation that it was abandoned, and the tube passed through the wound. The wound healed slowly though surely. Dr. Barton is inclined to recommend this way of feeding when primary union is not secured.

After-treatment.—If the patient is in good condition, if the foreign body has been removed early, or if the patient has been able to swallow liquids in the interval between the accident and the operation, he may be fed for the first few days by nutrient enemata and nutrient suppositories,* and only a little ice given occasionally by the mouth. But if the strength is not satisfactory at the time of the operation, or if the enemata are not retained, a soft feeding-tube must be made use of. This should be passed by the mouth and retained, if not very uncomfortable to the patient, or passed at intervals.† Towards the end of the first week, perhaps earlier if the wound is healing well, the patient may be allowed to swallow a little diluted wine or milk.

Chief Difficulties.

1. A fat, short neck.
2. Enlarged veins.
3. Wide depressors of hyoid bone.
4. Enlarged thyroid gland.
5. Unusual depth of œsophagus.
6. Detecting the site of the foreign body.
7. Firm gripping of the body by the œsophagus.
8. The foreign body may be dislodged during the operation.

Dr. Lediard (*Clin. Soc. Trans.*, vol. xviii. p. 297) records the case of a man in whom emetics and several attempts at removal had failed to dislodge a tooth-plate; emphysema of the neck was present, and some blood on the forceps used. Just before œsophagotomy, a bougie was thought to "scrape" as it was withdrawn. Nothing being felt when the œsophagus was exposed, a bougie was passed, and the œsophagus incised behind the cricoid cartilage; the finger now could detect nothing, and a bougie passed on seemed to feel the plate near the stomach. The plate was passed nineteen days after its impaction; it measured 1¼ inch by ¾ inch, carried one incisor, and had "numerous sharp points, and a formidable-looking hook at one end." Though there were no laryngeal symptoms, the plate must have been lying behind the lower end of the larynx, as the mucous membrane of the gullet showed here several ecchymoses. The dislodgment of the plate took place either during the passage of the bougie or in the administration of the anæsthetic. The patient made a good recovery.

Causes of Death.—These are chiefly:

1. Septicæmia.‡ The wound having become emphysematous, sloughy, and the discharge most foul.

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* Of these, the zyminised meat suppositories of Burroughs, Wellcome & Co. are amongst the best.

† Dr. Markoe (*Ann. of Surg.*, Sept. 1886), in the case of a man aged 24, from whom he removed, by œsophagotomy, half a tooth-plate which had been broken whilst eating, passed a soft india-rubber tube into the stomach through the wound, replacing this by one passed through the nose on the tenth day, and allowing the patient to swallow on the seventeenth day after the operation. The following are the reasons given for passing the tube through the wound:—(1) It ensures good drainage from the bottom of the wound; (2) anything regurgitated from the stomach passes through the tube, not up into the wound; (3) it is less unpleasant. The above reasons do not seem to me to outweigh the great risks and disadvantages of irritating and keeping open the wound, which it is desirable to have closed as soon as possible. As a rule, the tube should certainly be passed from the mouth or nose. It is noteworthy that in the above case the prolonged lodgment of the foreign body—six to seven weeks elapsing between the accident and the operation—had not caused any serious abrasion, &c.

‡ Mr. Butlin (*Clin. Soc. Trans.*, vol. xvii. p. 129) relates a case in which a tooth-plate

2. Exhaustion. When the body has been long impacted, and the patient's health has run down before the operation.

ŒSOPHAGOSTOMY.

This has been proposed as a substitute for gastrostomy. Mr. Reeves, who brought the subject before the Clinical Society (*Trans.*, vol. xv. p. 26), recommended this operation as less dangerous than gastrostomy, and in the belief also that cancer of the œsophagus is most frequently met with in the upper part of the tube.* The objections, however, are so great as to have prevented any adoption of this operation. They are —(1) the risk of coming close to a mass of cancer, which will not only not admit of dilatation, but which will be rendered more active, sloughy, &c., by the necessary irritation. (2) The fact that important parts are close by, and that the relations of these may very likely be much altered. (3) The probability of finding the œsophagus altered near the disease, and thus, perhaps, readily perforated, admitting fluids into the pleura, &c.

ŒSOPHAGECTOMY.

This is another operation introduced only to be abandoned. Prof. Czerny's case, it is true, was temporarily successful, the patient living rather more than a year after the operation. But cases equally suitable from the site of the disease—only just out of reach of the finger introduced from the mouth—with no glands involved, and no adhesions to adjacent parts, though symptoms had lasted five months, must be quite exceptional. Several of the risks given above would be intensified here, and there would be present as well the need of keeping the fistula patent.† De Quervain has collected all the cases (*Arch. f. klin. Chir.*, 1899, S. 858).

REMOVAL OF POUCHES OF THE ŒSOPHAGUS.

This affection has till lately been considered a very rare one. Mr. Butlin, who was one of the earliest operators, and the first in this country (*Trans. Med.-Chir. Soc.*, 1893, vol. lxxvi. p. 269), has published in a later paper (*Brit. Med. Journ.*, Jan. 1, 1898) six cases which he has seen, two of which were operated on by him, and with success. Dr. Maurice H. Richardson in a paper (*Annals of Surgery*, May 1900) states

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was removed within twenty-four hours of its being swallowed, previous attempts at removal, lasting thirty or forty-five minutes, having failed. No difficulty was experienced during the operation, but the patient sank from septicæmia four days afterwards. He was allowed to swallow on the second day, about a third of what was taken coming through the wound. Mr. Butlin considered this beneficial, as conducing to drainage. The wound was thoroughly washed with carbolic lotion and covered with carbolic oil. Two days after, the wound being very offensive, the dressing was altered to sanitas, changed every four hours.

* Most surgeons who have been called upon to pass bougies in these cases will agree with Dr. Goodhart, who, in the discussion on the above paper, said the disease, when advanced, usually extended from the cricoid cartilage nearly to the pylorus.

† Mr. Butlin (*Oper. Surg. Malig. Dis.*, second ed.) gives a case of Prof. Billroth's, where death was caused by the passage of the bougie into the tissues round the œsophagus, the opening where the lower end of the œsophagus had been stitched to the skin having contracted. In Mr. Butlin's opinion the results of the fourteen operations collected by De Quervain and others are very discouraging.

that fifty-six cases have now been recorded; of these eighteen have been operated upon, in most with success. Mr. Butlin, in his second paper, states his belief that "the rarity of this condition has been greatly exaggerated, and for this reason: the symptoms of the pouch are not generally known, and are usually mistaken for those of a yet rarer condition, viz., pouching of the œsophagus above a stricture, whether innocent or malignant. Both in Whitehead's case (*Lancet*, 1891, vol. i. Jan. 3, p. 11) and Chavasse's (*Path. Soc. Trans.*, 1891, vol. xliii. p. 82), gastrostomy was performed under the impression that the patient was suffering from stricture of the œsophagus, and the real nature of the condition was only discovered after the death of the patient."* The following are the chief symptoms, as given by Mr. Butlin in his paper quoted above.

The pouch is situated at the back of the junction of the pharynx and œsophagus. It occurs much more frequently in males, and the symptoms do not appear to have been noticed before the age of 40. Return of fragments of undigested food is the one constant symptom in every case, not immediately after the food has been taken, but many hours after. The return of food is sometimes associated with severe attacks of coughing. After some time a larger quantity of food is returned, and the patient becomes aware of some difficulty in swallowing, especially solid food. Pressure on the side of the neck, usually on the left side, causes fragments and liquids to return into the mouth, and if not, yet causes the escape of gas which is developed and collects in the pouch, and occasions much annoyance by gurgling up at frequent intervals during movements of the head and neck. If the pouch produces bulging in the posterior triangle, about the level of, or below, the cricoid cartilage, this is a very important symptom, but the absence of bulging does not in the least affect the diagnosis. A bougie is arrested at a distance of about nine inches from the teeth. It may perchance pass into the stomach, gliding over the orifice of the pouch, but the rule is that it passes into the pouch; and as the affection becomes more pronounced it may be impossible to pass an instrument down the œsophagus. If the bougie be of metal and slightly curved, its end may be made to project so that it can be felt and seen in the side of the neck (almost always the left side), behind the sterno-mastoid. Wasting and loss of weight are rarely, if ever, observed until the late stages of the disease. In fact, the patient may suffer from unmistakable symptoms of a pouch for years without any sensible loss of weight. Of course, in those cases in which the condition is gradually producing death by starvation, wasting slowly occurs during the last months or years. The course of the disease is very slow.

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* In Mr. Whitehead's case, the woman, æt. 57, whose symptoms had existed eight years, died six years after a most successful gastrostomy. Growing weary of this mode of feeding, and believing her old trouble to be cured, she resumed feeding by the mouth, and allowed the gastrostomy wound to close. Gradually the old dysphagia returned, and she sank from exhaustion. In Mr. Chavasse's case, the man, æt. 49, applied for relief too late. He was much emaciated from starvation, and sank two days after the gastrostomy. A case with very characteristic symptoms will be found reported by G. A. Wright, of Manchester (*Brit. Med. Journ.*, 1898, vol. i. p. 944). As the patient remained quite comfortable by emptying the pouch each time after swallowing food, operation was here deferred. In a case of Landauer's (*Centr. f. inn. Med.*, April 22, 1899), a Röntgen photograph, taken with thin leaden sounds *in situ*, gave more exact information as to the situation of the diverticulum.

Operation.—The patient being under the influence of an anæsthetic, it would be well, if this has not been already done, to adopt Mr. Butlin's advice and pass a slightly curved metal bougie into the pouch and make its end appear in the posterior triangle, thus obtaining the clearest proof of the presence of a pouch. If possible, a bougie should also be passed beyond the orifice of the pouch into the stomach, so as to prove that there is no stricture of the œsophagus. A long incision is then made along the anterior border of the left sterno-mastoid from the hyoid to just above the sternum. The omo-hyoid is divided, the superior thyroid vessels divided between double ligatures, the carotid sheath drawn outwards, and the larynx rotated on its long axis by drawing forward the left ala of the thyroid cartilage with blunt hooks. The pouch is then usually easily found lying behind the junction of the pharynx and œsophagus and projecting to the left side. If it be not found at once, careful dissection aided by the passage of a bougie will detect its position. It is then grasped by forceps and drawn out of the wound.. The following are some of the methods of dealing with it. Mr. Butlin in his two cases cut away the pouch from above downwards, the margins of the wound being drawn together with eight sutures of fine silk as the sac was cut away. This method is simple and easily employed. Bleeding does not seem to give any trouble at this stage. Dr. Richardson in one of his cases (*loc. supra cit.*) cut away the pouch, and, inverting the mucous membrane, united it with a few sutures of catgut, while the outer layers of the œsophagus were sutured with interrupted Lembert's stitches of silk. In his second case, on introducing his finger through the aperture by which the pouch communicated with the gullet, he found a constriction at this spot. Passage of the finger through this resulted in a longitudinal tear, the œsophagus just below the orifice of the pouch having the diameter of a lead-pencil. The tear was converted into a longitudinal slit by carrying an incision vertically down through the lower margin of the opening of the pouch and through the constriction. To prevent the occurrence of any permanent narrowing at the site of the tear, Dr. Richardson utilised a portion of the pouch to enlarge the diameter of the constricted œsophagus. A considerable circular margin having been left above the opening of the pouch, the lower portion of this margin was brought down and placed in the gap made by the incised posterior surface of the divided œsophagus. This gap was then sutured transversely, much as in pyloroplasty, while the orifice of the pouch was closed by uniting the margin in a vertical line, by Lembert's sutures. Quite a different method is that employed by Girard, of Berne. To avoid opening the œsophagus, he has twice invaginated the pouch so that it projects into this tube. The orifice, which after inversion points externally, is closed by three layers of sutures. Both of these cases were successful, the pouch probably becoming atrophied, as it no longer obstructed the passage of food. The first method—that employed by Mr. Butlin—is to be recommended on account of its combined efficiency and simplicity.

Owing to the very great risk of leakage, some form of drainage must be provided in every case where a diverticulum has been removed.

Either a drainage-tube or gauze wicks, or both, or gauze packing must be employed. Only the two ends of the wound are to be closed, though salmon-gut sutures of reserve may be placed in the rest of the wound, to be tightened when the necessity for drainage has ceased, as the wound is sometimes very slow in closing.

If the passage of a soft tube beyond the site of operation be easy and cause no irritation, the patient is best fed this way; otherwise he may be allowed to take liquids in the ordinary manner.

CHAPTER XVI.

OPERATIONS ON THE SPINAL ACCESSORY NERVE.

PARTIAL NEURECTOMY, OR NERVE-STRETCHING.

Indications.—In cases of spasmodic torticollis in which—1. All previous palliative treatment has failed; *e.g.*, large doses of conium, massage, galvanism of the affected side, and faradisation of the opposite muscles. 2. The spasms so severe and constant as to interfere with the patient's taking food or enjoying sleep, and to cause sad weariness and real suffering. 3. The only muscles affected are the sterno-mastoid, or the sterno-mastoid and trapezius.

Anatomy of the Spinal Accessory Nerve.—The spinal or external part of this nerve, having left the skull by the jugular foramen, is directed backwards in front of, or behind, the internal jugular vein, and appears below the digastric and the occipital artery. It then descends obliquely outwards to the sterno-mastoid muscle, and disappears under this at a distance of two inches from the apex of the mastoid process. Having usually perforated the muscle, the nerve passes across the posterior triangle, to end in the deep surface of the trapezius. While passing through or under the sterno-mastoid the nerve joins with branches from the second cervical. Having emerged from the muscle, it joins with the second and third nerve, and is often in intimate connection with the great auricular and small occipital. When under the trapezius, it is joined by branches of the third and fourth cervical.

Operations for Partial Neurectomy, or Stretching of the Nerve.—These may be considered together, but it may be said, once for all, that, as stretching will be followed by but temporary benefit, resection of the nerve will be the better operation.

The nerve may be found by two different incisions:

A. Along the anterior border of the sterno-mastoid, so as to come upon this nerve before it perforates this muscle.

B. Along the posterior border of the muscle; the surgeon finding the nerve as it emerges here to cross the posterior triangle to gain the trapezius, and following it up to a point above its branches to the sterno-mastoid, so as to paralyse this muscle also.

The first of these operations is, in my opinion, much preferable, and for these reasons:

1. Though the nerve lies more deeply at the anterior than at the posterior border of the muscle, it is here a single nerve, and not likely to be confounded with other nerves—*e.g.*, branches of the second and third cervical, which also emerge at the posterior border to supply the skin. Furthermore, in this latter position the spinal accessory is often found in close connection with the small occipital and great auricular, as these two nerves appear at the posterior border and curve upwards.

2. By finding the nerve at the anterior border of the muscle, paralysis of the sterno-mastoid is better ensured. When the nerve is found at the posterior border and followed up into the muscle before division, there is always an uncertainty as to whether some branch to the muscle may not have come off above the point at which the surgeon has divided the nerve. And though the nerve is more superficial in the posterior triangle, it is difficult to make certain whether it is the spinal accessory or one of the superficial cervical nerves which emerge close to it from behind the muscle.

A. **Operation above the Sterno-mastoid.**—The parts having been shaved and sterilised, and the head suitably raised and turned to the opposite side, the surgeon makes a free incision along the anterior border of the sterno-mastoid for 3 inches, commencing at the apex of the mastoid process and ending about 2 inches below the angle of the jaw. Skin, fasciæ, and platysma being divided, the anterior border of the sterno-mastoid is clearly defined, and drawn strongly backwards so as to put the nerve on the stretch. In doing this the posterior and lower part of the parotid may have to be drawn forward if this gland overlap the muscle. The wound being then thoroughly dried, the operator searches for the nerve with a steel director in the fatty connective tissue which lies between the muscle and the carotid sheath. If, in doing this, he keep for his landmark the angle of the jaw, he is almost certain to be on a level with the point where the nerve enters the muscle. If this landmark fail him, he should define the lower border of the digastric, and, tracing upwards the posterior belly of this muscle, feel for the transverse process of the atlas, between the front of which process and the posterior belly of the digastric the nerve emerges to pass backwards to the sterno-mastoid. The small branch from the occipital artery which accompanies the nerve will give no trouble; and if in the deeper parts of the wound only a steel director or a blunt dissector be used, neither the occipital artery nor the internal jugular vein will be injured. A full inch of the nerve should be removed.

B. **Operation Below or at the Posterior Border of the Sterno-mastoid.**—Mr. Campbell de Morgan, who introduced this operation into British surgery with a very successful case,* made an incision, 2 inches long, along the posterior border of the sterno-mastoid, the centre of the incision corresponding to about the centre of this border of the muscle. The fascia being slit up to the same extent, the trapezial branch of the nerve was sought for as it emerges from the sterno-mastoid to cross the posterior triangle. It was found a little above the centre of the wound, and traced through the muscle till the common trunk was discovered above its division into branches for the trapezius and sterno-mastoid. Half an inch of the nerve was then cut out.

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* *Brit. and For. Med.-Chir. Rev.*, July 1866.

I have thrice performed the operation of resection of part of the spinal accessory, employing each of the two methods given above.

Thus, in 1878, I found the nerve in the posterior triangle, and, tracing it upwards, removed a portion of the common trunk in the substance of the sterno-mastoid. In 1894 I found the nerve at the anterior border of the muscle, taking as my guide the angle of the jaw. Both patients were middle-aged women, the subjects of severe spasmodic torticollis. In each case some of the deep cervical muscles supplied by the upper cervical nerves were affected, and in neither was the result so satisfactory as I wished. In the first no permanent benefit can be said to have resulted. In the second the relief was considerable, and the patient has, hitherto, declined further operation in the form of division of the posterior branches of the cervical nerves. Atrophy of the sterno-mastoids followed in each case.

In my third case, as both sterno-mastoids were affected, excision of part of each spinal accessory was performed above the sterno-mastoid. While the muscle on the left side remained paralysed, the right contracted afterwards as vigorously as before. There was no doubt whatever that the nerve had been found and part removed, for it was absolutely quiescent for three weeks after the operation. Whether the return of activity was due to reunion taking place, or to the additional nerve-supply from the second cervical, must remain doubtful. I find the same result has occurred to Mr. Harsant, Surgeon to the Bristol Royal Infirmary (*Bristol Med.-Chir. Journ.*, [illegible]). This case, of twenty years' duration, was rendered further unfavourable by the number of muscles involved. Thus, when the head was fixed by the sterno-mastoids and trapezii in rigid spasm, the platysma, occipito-frontalis, and orbicularis palpebrarum were also in violent action, the arms were rigid, and the abdominal recti were powerfully contracted. Though on each side three-quarters of an inch of the spinal accessory was removed, it is stated that some weeks later "there was no actual paralysis of either sterno-mastoid or trapezius, which all appeared to contract violently at times."

There is no comparison between the two methods, that in which the nerve is found at the anterior border of the muscle being infinitely easier and more satisfactory.

A very interesting contribution to the literature of this subject is a paper by Mr. Ballance.*

His patient, a woman of 48, was a good instance of the distress and misery due to spasmodic torticollis. Division of the right spinal accessory in the anterior triangle gave most decided relief. At the end of four months, when the history ceases, the patient is reported to have been "much better and stouter. The face is happy and tranquil. There is neither headache nor pain, and sleep and appetite are good. The control of the movements of the head is perfect as long as she is not excited, and so long as the head is not raised so that the eyes are directed much above the horizontal plane in which they lie. . . . . The right sterno-mastoid and trapezius are atrophied."

Division of the spinal accessory deserves a further trial, even if the relief given be not permanent.

The chief fear is that other muscles will become involved, as in many cases. Thus, Mr. Ballance writes of his patient: "Since the operation it has been certain that some of the muscles supplied by the upper spinal nerves are liable to spasm. It would be strange if it were not so, considering the intimate connections between the second, third and fourth spinal nerves and the spinal accessory in the sterno-mastoid.

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* *St. Thomas's Hosp. Rep.*, vol. xiv. p. 95. Other successful cases will be found recorded by Prof. Annandale (*Lancet*, 1879, vol. i. p. 555) and by Mr. Southam (*ibid.*, 1881, vol. ii. p. 369); Mr. Rivington also operated (*ibid.*, 1879, vol. i. p. 213), but phlegmonous erysipelas carried off the patient before the wound was quite healed.

trapezius, and posterior triangle, together with the fact that some of the fibres of the spinal accessory are connected with the same cells, or with cells in the immediate neighbourhood of those from which arise the motor rootlets of the cervical spinal nerves."

The following conclusions may be drawn with regard to the operative treatment of spasmodic torticollis:—1. Palliative treatment will be of little permanent value, and the earlier surgery is resorted to the better the outlook. 2. The most common combination of spasm is that involving the sterno-mastoid on one side and the posterior rotators on the other, the head being held in the position of sterno-mastoid spasm with the addition of retraction through the greater power of the posterior rotators (Dr. Maurice H. Richardson and Dr. G. L. Walton, *Amer. Journ. Med. Sci.*, 1895, No. cix. p. 27). 3. Operation on the spinal accessory may afford relief, even if other muscles than the sterno-mastoid are affected. On the other hand, the affection previously limited to the sterno-mastoid may spread to other muscles in spite of this operation (*ibidem*). 4. No fear of disabling paralysis need deter us from recommending operation, as the head can be held erect even after the most extensive resection (*ibidem*). 5. It is clear from Mr. Harsant's cases as well as my own, that, after undoubted resection of portion of the spinal accessory, spasmodic action of the sterno-mastoid may still persist. 6. I have spoken above of the need of resorting to surgery early in these cases. The disease will certainly spread from one muscle to another, from one group to another, the abnormal condition of one nerve-centre extending to other closely adjacent centres. Further, it is here as in traumatic epilepsy of any duration (p. 222): over-excitability of one or more nerve-centres becomes, if left too long, a permanently established condition, and with it over-activity of the muscles which are physiologically associated with those nerve-centres.

Resection of some of the Branches of the Upper Cervical Nerves.—In those cases of spasmodic torticollis where, after resection of part of one spinal accessory, mischief still persists in muscles of the opposite side, this step has been practised by Mr. Noble Smith in this country, and by Prof. Keen, of Philadelphia. The following is the account of the steps taken by Mr. Noble Smith (*Brit. Med. Journ.*, vol. i. 1891, p. 753):

> The patient was a lady, aged 41, in whom the last-mentioned surgeon had first stretched and then resected part of the left spinal accessory. Though the result of the latter operation was "complete paralysis of the sterno-mastoid and trapezius, the spasms on the right side continued, the splenius capitis being the greatest offender. On May 28, 1890, I made an incision from the occiput downwards for about three inches, parallel to and about an inch to the right of the spinous processes, through the trapezius down to the edge of the splenius, some of the fibres of which muscle I had subsequently to divide to enlarge the wound, then through the complexus, and eventually exposed the posterior branches of the cervical nerves. The great occipital then came into view, and this I had to draw aside. I excised a piece of the external division of this nerve, also of the third and fourth posterior branches. Considering the extensive connection of nerves in this part, I thought it well to separate the splenius from the parts beneath it, and search for and divide any filaments of nerve passing into that muscle. I also acted in the same manner towards the complexus. I had intended to try and excise a piece of the sub-occipital nerve, but having already made a rather deep dissection, and found that some veins interfered with such further operation, I desisted from doing any more.

. . . . The first night of the operation, the patient, for the first time for sixteen years, was able to rest her head on her elbow without spasmodic action. This good result has continued. . . . . The loss of power proved to be very slight indeed."

Prof. Keen's method is different (*Journal of Nervous and Mental Diseases*, Dec. 1889):

The parts being shaved and disinfected, a transverse incision, three inches long, is made about half an inch below the lobule of the ear, from the middle line of the neck posteriorly. The trapezius is then divided transversely, dissected up, and the great occipital found as it emerges from the complexus, usually about half an inch below the incision, to enter the trapezius. The complexus is next divided at the level of the nerve, care being taken not to cut the nerve, which is then traced down to its origin from the posterior division of the second cervical. A portion of this division is resected. The inferior oblique being recognised, the sub-occipital is traced into its triangle and a portion resected. An inch below the great occipital, and under the complexus, is the outer branch of the posterior division of the third cervical to the splenius. This should be resected close to the bifurcation of the main trunk. The wound is very deep, and an electric light will be found a great help. Drainage must be provided, and the divided muscles may be united by buried sutures.

RESECTION OF THE CERVICAL SYMPATHETIC FOR EXOPHTHALMIC GOÎTRE.

Owing to the uncertainty of the results and the dangers accompanying partial thyroidectomy in exophthalmic goître (p. 547), some surgeons, in recent years, relying on the suggestion originally, I believe, put forward by Trousseau, that the three cardinal phenomena of the disease are due to some disturbance of the cervical sympathetic, have practised removal of these ganglia. This method of treatment does not appear to me to be based on sound foundations, or to be followed by good results with sufficient constancy to justify our resorting to it. Thus, even if morbid changes in the ganglia were constantly present in this disease (a postulate which cannot be conceded), any attempt to explain the three cardinal symptoms of exophthalmic goître is unsatisfactory. Thus, while the exophthalmos and the goître may be explained by paralysis, the third chief feature, the excited heart's action, means irritation, not paralysis, of the above ganglia.

With regard to the results of this mode of treatment of exophthalmic goître, I cannot find that they are more constantly beneficial than those following partial thyroidectomy, and this is especially the case with reference to those nervous symptoms which are so frequent and distressing a feature in this disease.

The following are amongst the papers by surgeons who have made use of this operation:—Jaboulay, who first gave prominence to it (*Lyon Méd.*, Feb. 7, 1897, *Presse Méd.*, Feb. 12, 1898); in the second paper eleven cases are given, and the writer speaks of the operation as especially preferable to partial thyroidectomy in those cases in which the goître is not a prominent feature. Péan (*Presse Méd*, Aug. 4, 1897); this surgeon obtained relief to the pressure symptoms, but not to those which may be termed nervous. Poncet (*Presse Méd.*, July 28, 1897); here benefit in nine cases is claimed. Chauffard and Quénu (*Presse Méd.*, July 3, 1897); in these writers' hands the result was entirely negative. Gouget (*Lyon Méd.*, Nov. 30, 1896) speaks favourably of Jaboulay's method, and claims that the three cardinal features of exophthalmic goître are powerfully influenced by it. Réclus (*Presse Méd.*, June 23, 1897) reports a case completely cured by this treatment. Schwartz (*Bull. et Mém. de la Soc. de Chir. de Paris*, Nov. 22, 1898) reports two cases treated by bilateral resection of the cervical sympathetic. In both cases the operation is stated to have given much relief, bringing about less marked exophthalmos, reduced frequency of the pulse, and gradual improvement in the general symptoms.

Operation.—An incision is made parallel to the posterior border of the sterno-mastoid and along its whole length. After division of the deep cervical fascia, the carotid sheath with its contents is drawn inwards, and the grey cord of the sympathetic exposed. The three ganglia are then removed. The operation is performed on both sides.

An interesting paper by Mr. Burghard on excision of the superior cervical ganglion will be found in the *Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1175. The operation was performed on three occasions for very different conditions: in the first case, for the relief of subacute glaucoma; in the second, for the removal of an enlarged epitheliomatous gland adherent to the upper ganglion; and, in the third, for a variety of false neuroma which had attacked the ganglion. Here the middle ganglion was removed as well. The operation was successful in the second and third cases; in the first no benefit followed.

As it is chiefly in glaucoma that this operation is likely to be repeated, I append from Mr. Burghard's paper the following results of the operation, as given by Jonnesco, of Bucharest, who first performed it in September, 1897:

"In Jonnesco's list there are seven cases of subacute or chronic glaucoma, accompanied by more or less complete loss of vision, and one acute case. The results of these are summarised by the author as follows:

"(*a*) Immediate and lasting decrease of intra-ocular tension in all the cases.

"(*b*) Marked contraction of the pupils, which was permanent, even in the cases which had been previously iridectomised.

"(*c*) Loss of the frontal headache.

"(*d*) Disappearance of the paroxysms in the cases of irritative glaucoma.

"(*e*) Marked and permanent improvement of vision in all the cases in which the persistence of definite vision, or even perception of light, showed that the papillæ had not undergone atrophy. This improvement was remarkable in its suddenness and its progressive tendency, but was absent in the case of acute glaucoma, and in two of the chronic irritative forms."

CHAPTER XVII.

LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.*

LIGATURE OF THE TEMPORAL ARTERY.

Indications.—These are very few, viz.:

1. Wounds—*e.g.*, stabs and gunshot injuries.
2. Aneurysm, usually traumatic.

Mr. Skey (*Oper. Surg.*, p. 289) met with a case of aneurysm of doubtful origin in this artery in a young lady. Ligature of the vessel below having failed, he cured his patient by means of a fine spring-compress with a ball-and-socket joint, which, passing over the head, entirely concealed by the hair, made pressure on the tumour.

Aneurysms have been known to occur here after the operation of arteriotomy. They should be treated, as the one just recorded should have been, by the old method.

GUIDE.—A line drawn upwards over the root of the zygoma, midway between the condyle of the jaw and the tragus.

RELATIONS.—Given off behind the jaw, this vessel passes up, midway between the above two points, over the zygoma, and at a point 1½ or 2 inches higher up it divides into its anterior and posterior branches. Lying at first in the parotid gland, it is covered a little higher up by a dense fascia passing from the parotid to the ear, by the attrahens aurem, often a lymphatic gland, and one or two veins which lie superficial but close to it. Some branches of the facial nerve cross it, while the auriculo-temporal nerve accompanies it closely. Higher up, the artery and its branches are particularly subcutaneous.

Operation.—The parts having been shaved and sterilised, the head fitly supported and turned to the opposite side, an incision about one inch long is made in the line of the artery so as to tie it just above the zygoma. The dense subcutaneous tissue and the strong parotid fascia being cleanly divided, the artery must be accurately defined, and the vein being drawn to one side, usually backwards, the ligature should be passed from behind forwards, care being taken to include only the artery.

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* Ligature of the thyroid arteries has already been considered, chap. xiii. p. 549.

Arteriotomy.—A few words may be said here about this seldom-used operation. The surgeon, having defined the anterior division of the temporal, steadies the vessel by placing his finger just beyond the point which he intends to open, and then with a small sharp scalpel lays open the vessel till it is about half cut through. The blood required having been removed, he divides the vessel completely, so as to allow the ends to retract, applies a pad of sterilised gauze, and retains this in position with the twisted or knotted bandage for the head. The pad should not be removed for four or five days.

The reasons for preferring the anterior division to the trunk of the vessel are the following:

(1) The latter lies much more deeply, under fasciæ, and in the parotid below; thus so much pressure may be required to stop the bleeding as to cause sloughing, secondary hæmorrhage, and dangerous erysipelatous inflammation.

(2) Injury to one of the adjacent nerves may cause severe pain and tedious healing.

(3) From opening a vein at the same time an arterio-venous aneurysm may result.

LIGATURE OF THE FACIAL ARTERY.

Indications.—These are much the same as, but still fewer than, those for ligature of the temporal artery.*

The vessel's course is divided into a cervical and a facial part.

Cervical Part.—Ligature of this part can be scarcely ever required. The vessel could be reached here by an incision similar to that for the external carotid (p. 604) or the lingual (p. 579). In either of these cases it would be found just below the posterior belly of the digastric and the stylo-hyoid, these muscles being drawn upwards to enable the surgeon to ligature the vessel just before it enters the sub-maxillary gland.

RELATIONS IN THE NECK.—The facial artery is given off just above or in connection with the lingual, about an inch above the bifurcation of the common carotid. It passes upwards and inwards to the lower jaw, being covered by skin, fasciæ, and platysma, the digastric and stylo-hyoid, and embedded in the sub-maxillary gland, to which structure the vein lies superficial. The tortuous outline of the vessel is well known. The vein, running a straighter course, lies posterior to the artery.

Facial Part.—The artery is readily secured by a small horizontal incision just below the jaw in front of the masseter muscle, the anterior border of which should be first defined, this being easily done on the living subject by telling the patient to throw it into action. The incision should be made carefully, so as to avoid any branches of the facial nerve which may lie in the way. The artery will now be felt when rolled upon the bone by a finger. The ligature should be passed from behind forwards, so as to avoid the adjacent vein.

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* The reader is advised to take every opportunity afforded upon the dead body to tie these and other arteries, though apparently so small and unimportant, as only by such practice can dexterity be really acquired.

LIGATURE OF THE OCCIPITAL ARTERY.

Indications.

1. Stabs.
2. Gunshot wounds.

In the *Medical and Surgical History of the War of the Rebellion*, part i. p. 422, two cases are given of secondary hæmorrhage after wounds of the neck, in the one case from the occipital, in the other from a branch of it; in the former case 16 ounces of blood were lost. The vessel was tied in the wound in each case, two ligatures being, of course, applied.

3. In the treatment of arterial varix, cirsoid aneurysm, or aneurysm by anastomosis on the head (p. 599).

4. For hæmorrhage from an abscess in the neck. Sir W. Mitchell Banks[*] has published a most instructive case:

A weakly man, aged 32, had had a suppurating gland incised three weeks before admission. Poultices were applied, and a week after, during a violent attack of coughing, blood burst from the wound "like a tap being turned on." Three times afterwards hæmorrhage ensued, pressure being applied in vain. On admission he was in the last stage of exhaustion. The right side of the neck from ear to clavicle was occupied by a great fluctuating swelling. In front of the sterno-mastoid, about half-way down, was the original incision, from which a little sanious discharge was issuing. Behind the muscle a piece of skin about an inch square was actually sloughing from the subjacent pressure. Under ether, and in a good light, the original incision was enlarged upwards and downwards, and a quantity of putrid broken-down clot turned out. Then a similar incision was made behind the sterno-mastoid through the sloughing skin. Everything being mopped and cleaned up, blood was found to be trickling down from somewhere very high up. To get at it, the sterno-mastoid and skin over it were cut clean across, thus uniting the two vertical incisions by a transverse one. The muscle was dissected upwards, exposing the sheath of the carotid vessels, but still the blood always kept running from some deep-seated point high up. At last this was reached, just in front of the transverse process of the atlas. From it arterial blood issued, and an aneurysm-needle was thrust through the tissues on each side of it and ligatures applied, which at once checked all further bleeding. The vessel was the occipital artery not far from its origin. Into it the abscess had made its way. The great wound was rapidly swabbed out with turpentine and then stuffed with lint dipped in the same. The patient was very near to death's door, but ultimately recovered.[†]

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[*] *Clinical Notes upon Two Years' Surgical Work at the Liverpool Royal Infirmary*, p. 161.

[†] Such was the patient's condition that the surgeon was quite prepared for his dying under the operation. The following characteristically vigorous words conclude the account: "But I was determined, as long as he had any blood to run out of him, the place whence it came should be found and tied." In connection with this case may be quoted, in his own words, some remarks of the writer on the value of turpentine as a cleansing styptic. This remedy has again lately been recommended, and it is only fair that Sir W. Mitchell Banks should receive the credit of having recognised its value many years ago. "In former days it was the regular thing for oozing, until superseded by the introduction of perchloride of iron. This has always seemed to me most unfortunate, as iron is the very worst of all styptics. Owing to its great potency and the rapidity with which it acts, it soon became popular, and is at the present moment the favourite stand-by of the chemist, who diligently swabs with it every cut that is brought into his shop, preparatory to sending the patient off to a hospital. As a result, the wound is covered with a cake of coagulated blood, and its surfaces are sometimes positively killed by the strength of the application. Beneath this firmly adherent crust all sorts of purulent, filthy secretions accumulate, till at the end of forty-

Relations.—A posterior branch of the external carotid, the occipital comes off opposite to or a little above the facial, just below the digastric. It at first ascends, having the ninth nerve hooking round it, under the digastric, stylo-hyoid, and parotid, and crossing the internal carotid, internal jugular, vagus, and spinal accessory. Having reached the interval between the transverse process of the atlas and the mastoid process, it now, in the second part of its course, turns horizontally backwards, grooving the temporal bone, covered by the sterno-mastoid, splenius, digastric, and trachelo-mastoid, and lying on the complexus and superior oblique. In the third part of its course it runs vertically upwards, piercing the trapezius, and ascending tortuously in the scalp.

Operations.

1. If the artery require securing low down, this may be effected much as in tying the external carotid, an incision being made along the anterior border of the sterno-mastoid, the deep fascia opened, and the digastric and ninth nerve exposed. Care should, of course, be taken to avoid the latter.

2. To tie the artery behind the mastoid process, *e.g.*, when it has been wounded by a stab in the neck, the following steps should be taken: The parts being cleansed, and the head at first being placed in much the same position as for ligature of the carotids, an incision is made from the tip of the mastoid process rather obliquely upwards, so as to lie over a point midway between the mastoid and the external occipital protuberance. The tough skin and fasciæ being incised, the posterior half of the sterno-mastoid, with its strong aponeurosis, and next the splenius capitis, must be divided, together with any fibres of the trachelo-mastoid that are in the way. The wound being somewhat relaxed by turning the head over to this side, retractors deeply inserted, and a laryngeal mirror used if needful, the artery will be found deep down between the mastoid process and the transverse process of the atlas.

In separating it from its vein, one or more veins varying in size may be met with, forming communications between the occipital and mastoid veins, and thus with the lateral sinus. The wound should therefore be kept rigidly aseptic.

LIGATURE OF THE LINGUAL ARTERY (Fig. 214).

Indications.

1. Before removal of the tongue. This subject has been considered at

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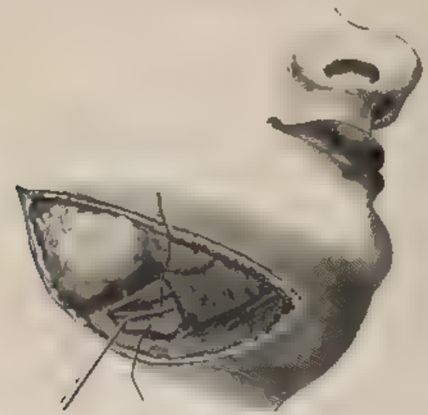
eight hours it stinks abominably, and requires to be well poulticed to get it clean. Should bleeding recur, the difficulty of finding the spot is enormously increased by the mass of pus and almost cineritious hard clots which cover it. I have seen so many cut hands almost ruined by it that I have totally abandoned it. On the other hand, turpentine is nearly as powerful a styptic, and is a most marvellous cleanser and sweetener. The plug soaked in turpentine comes out quite easily at the end of four-and-twenty hours, leaving a wholesome surface behind it. For all wounds about the perinæum, such as lithotomy wounds, fistula cuts, or incisions for extravasation of urine, there is nothing like it, and I trust it will soon be reinstated in surgical favour. Our forefathers had some excellent remedies, and this is one of them." I have used sal alembroth gauze soaked in turpentine, with excellent results, after removal of a kidney, the seat of a most fœtid discharging pyonephrosis. Only the gauze, &c., *in* the wound must be thus soaked.

p. 457. 2. After removal of the tongue, to arrest hæmorrhage. 3. In cases of tongue cancer not admitting of operation, in the hope of checking the rate of growth, diminishing the fœtor, profuse salivation, &c. This step is uncertain as to the amount of good which it effects, and any good that it may do will not be long-lived.* 4. In cases of macroglossia this operation may be tried before removing a wedge-shaped piece of the tongue; it would require to be performed on both sides, and would be attended with considerable difficulty in a child. It might do too much.

Relations.—The lingual artery arises about a quarter of an inch above the superior thyroid, often in common with the facial, and at a point opposite to the great cornu of the hyoid bone. It first ascends to a point rather above the level of the hyoid bone, then descends somewhat

Fig. 214.†



The sub maxillary gland is seen in the upper part of the wound. Below this is the hypo glossal on the cut hyo-glossus. A ligature is passed between the lingual artery and vein. A hook depresses the great cornu of the hyoid bone. The lower part of the hyo-glossus is reflected. Lowest of all is the digastric.

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* Mr. Haward (*Clin. Soc. Trans.*, vol. x. p. 129) related a case in which he tied the left lingual artery for recurrent epithelioma. The recurrent growth was the size of half a walnut when the lingual artery was tied. It at once ceased to grow, became pale, and in a few days was sloughing. Gradually separation of the growth went on, until the affected side of the root of the tongue became even smaller than the sound side, and eventually the part healed. A fortnight after this took place, or three months after the ligature of the artery, the patient died of pyæmia, set up by erysipelas coming on after the operation. Mr. Haward pointed out that the greater part of the tongue had been removed before the ligature of the lingual, so that therefore the anastomoses between the arteries of the two sides would be greatly diminished. I think also, that the fact that Mr. Haward was obliged to tie the artery close to the external carotid may have contributed to the sloughing, by cutting off the entire blood-supply, especially that through the dorsalis linguæ.

On the other hand, Billroth (*Clin. Surg.*, p. 113) states that, in one case of cancer of the tongue, "the lingual artery was ligatured on both sides, in the hope that the infiltration of the tongue in the cavity of the mouth might diminish. However, the ligature led to no good results, nor did any rapid breaking-down of the already ulcerated new formation occur."

† The lingual artery is here drawn too large, and too much of the vessel is shown cleaned; the depth of the wound is not sufficiently represented.

and runs just above the great cornu, and finally, ascending to the under surface of the tongue, it runs forward with a tortuous course to the tip as the ranine.

For practical purposes the relations of the artery may be subdivided into **three parts**—the **first,** before it gets under the hyo-glossus; the **second,** while it lies beneath this muscle; and the **third,** beyond this muscle.

In **the first** it runs very deeply, though only covered by the skin, platysma, and fasciæ, facial, lingual, and some pharyngeal veins; it lies upon the middle constrictor and the external laryngeal nerve.

In **the second part** of its course the artery again lies upon the middle constrictor, and is now covered by the hyo-glossus, hypo-glossal, part of the mylo-hyoid, and the lower border of the sub-maxillary gland. From this part come off the four branches of the artery—the hyoid at the outer or posterior edge of the hyo-glossus, the dorsalis linguæ under this muscle, and the sublingual and ranine at its anterior border, thus allowing room for placing a ligature.

The third part lies in the mouth, and runs along the under surface of the tongue up to the point of the frænum. It is only covered by mucous membrane. A vein runs with it, and a large branch of the gustatory nerve.

Operations.

i. **Ligature under the Hyo-glossus.**

ii. **Ligature of the First Part of the Artery.**

i. The vessel is usually tied while **under the hyo-glossus muscle,** owing to the useful guide which the great cornu of the hyoid bone forms, and this is the operation which will be described here (Fig. 214). Were I tying the artery previous to removal of the tongue (p. 458), I should do this close to its origin by an incision similar to that for the external carotid (p. 604), so as to make sure of getting behind the dorsalis linguæ. The parts being shaved, the head suitably supported and turned to the opposite side, and the lower jaw firmly closed, the surgeon, standing or seated on the same side, steadies the tissues between his left finger and thumb, and makes a curved incision with its centre just above the great cornu of the hyoid bone (a point previously carefully noted), and reaching, *e.g.*, on the left side, from just below and to the left of the symphysis downwards, backwards, and then upwards towards the angle of the jaw, ending just anteriorly to the line of the facial artery.

The incision divides skin, superficial fascia, and platysma; the deep fascia is then opened, and any branches of the anterior jugular, facial, or communicating branch with the temporo-maxillary vein are secured carefully, so that the wound may be kept as dry as possible. The lower border of the sub-maxillary gland, which probably projects into the wound, is turned upwards* and the hypo-glossal nerve sought for, which lies deeper, and is a good guide to the hyo-glossus. Lower down in the neck is the glistening tendon of the digastric attached to the hyoid bone. The hyo-glossus being defined, the hyoid bone is carefully steadied by a finger-nail or tenaculum, a director passed under the hyo-glossus, and this muscle divided cautiously. In doing this the lingual vein must be carefully looked for either on the muscle or beneath it, with the artery. The artery having been found under the muscle just above the hyoid bone, it should be traced backwards so as to apply, if possible, the ligature behind the origin of the dorsalis linguæ. Adequate drainage must be provided, and every care taken to prevent decomposition in a wound so deep, and opening up several planes of deep cervical fascia. Any enlarged glands will, of course, be removed.

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* The sub-maxillary gland should be gently handled, and not cut into. Otherwise in the one case troublesome swelling, in the other temporary weeping of saliva, or even a fistula, will be the result.

Guides and Aids to finding the Artery.

1. A sufficiently free incision. 2. Carefully defining the hypo-glossal nerve, and remembering the relative position of the sub-maxillary gland, the digastric tendon, and the great cornu of the hyoid bone. 3. Keeping the wound bloodless.

Difficulties.

1. Matting of the parts from old cellulitis. 2. Presence of large veins. 3. Depth of the wound, and oozing low down from the severed hyo-glossus. 4. In one case Dr. Shepherd (*Annals of Surgery*, vol. ii. No. 11, p. 359) found the digastric so extensively tied down to the hyoid bone by the deep cervical fascia as to require separation. 5. The position and condition of the lingual vein alike are at times perplexing. Usually it lies on the hyo-glossus; occasionally it lies under it, with its artery. Billroth (*Clinical Surgery*, p. 113), who has tied the lingual artery twenty-seven times, tied the vein for the artery in one case, as was verified post mortem. "Every surgeon knows the difficulty of tying the lingual artery in old people; the vessel lies so deep that it is very difficult to distinguish it from thick-coated distended veins, especially when, owing to heart-disease—as in this case—the veins pulsate. Never previously had I met with a lingual vein of such thickness." 6. Abnormal position of the lingual artery itself. This is rare, but the artery may lie higher than usual; it may pierce the hyo-glossus; occasionally, one lingual is minute or absent. 7. The sub-maxillary gland may be unusually large and occupy much of the space between the jaw and the hyoid bone.*

ii. If the vessel cannot be found on the hyo-glossus, or if the condition of the soft parts is such, owing to cellulitis, matting, or enlargement of glands, as to prevent any attempt being made here, the surgeon must cut down upon the **first part** either by an incision similar to the above but less curved, and running from the centre of the hyoid bone just above the great cornu to the anterior border of the sterno-mastoid, or by one similar to that used for ligature of the external carotid, with its centre opposite to the hyoid bone.

The difficulties are not great. It needs only to remember that—1. The artery itself is not constant in position here, varieties occurring frequently in the height at which it comes off from the external carotid, whether alone, or in common with the facial. 2. Large veins—*e.g.*, the lingual and facial—will certainly be present.

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* Dr. Shepherd, *loc. supra cit.*, p. 361.

LIGATURE OF THE COMMON CAROTID

(Fig. 215).

Indications.

1. In wounds of the trunk itself. Owing to the rapidly fatal issue of such injuries, the surgeon is not often called upon to meet them.* Cases indicating ligature for wounds of the trunk may be grouped as follows: (*a*) For immediate hæmorrhage; (*b*) for secondary hæmorrhage; (*c*) for gunshot injuries.

(*a*) *For Immediate Hæmorrhage.*—Ligature of the common trunk is here rarely called for, as above stated. In civil practice, such cases may occasionally occur in cut-throat. If the surgeon arrive in time, he should arrest the hæmorrhage, while waiting for assistance, by thrusting one or more fingers into the wound, and making pressure on the bleeding point, remembering that but slight force is required if the pressure is on the right spot. If the patient has to be removed any distance, finger-pressure must be kept up, or the wound plugged with a sterilised sponge or aseptic gauze, and the head kept rigidly still. Pressure with a finger or with a sponge on a holder should be kept up on the bleeding point while the wound is enlarged, and the opening in the carotid secured by ligatures placed above and below it.

Mr. Butcher, in a case of suicidal cut-throat implicating the common carotid, successfully ligatured the artery above and below, the patient making an excellent recovery.

While on this subject, I may refer to the following case of Mr. Guthrie's (*Wounds and Injuries of Arteries*, p. 78), which shows that if the carotid is wounded, though not opened, it is best to apply ligatures above and below.

In a case of attempted suicide, the cut was deepest on the left side, having laid bare the left carotid and wounded the internal jugular. "The opening into the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and, drawing them together, passed a single silk thread around so as to close the opening without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and, after due consideration, it was presumed that this wound might heal without requiring a ligature to be placed upon the artery. On the eighth day arterial hæmorrhage took place, and, on opening the wound, it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common into the external and internal carotids. The hæmorrhage ceased on placing a ligature on the external carotid, and, as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness." At the necropsy the internal jugular was found pervious and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about a quarter of an inch with a soft clot, the wound in the common carotid was exactly below its bifurcation and Mr Guthrie thought that the ligature on the external carotid might have been sufficient.*

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* These, in reality, rare wounds of the common carotid might, at first sight, be thought to be more common, owing to the inaccuracy with which wounds of the external carotid have been quoted as those of the common trunk.

Mr. Guthrie mentions (*loc. supra cit.*, p. 79) another case in which the common carotid was wounded by a penknife, and the hæmorrhage arrested by tying the vessel above and below the wound.

(*b*) *For Secondary Hæmorrhage.*—A remarkable instance of punctured wound of the common carotid in which the vessel was tied for secondary hæmorrhage is thus recorded by Mr. Durham:†

A child, aged 9, was wounded with glass, owing to an explosion of hydrogen gas. When admitted into Guy's Hospital, under the care of Mr. Hilton, the child was cold and blanched, but the bleeding, which had been profuse, had entirely ceased. There was a wound about an inch long "in the left carotid region." On the eighth day after the accident, hæmorrhage recurred, and the common carotid was tied. Nine days later slight bleeding took place, but was arrested by plugging the wound with sponge. Repeated epistaxis occurred, which weakened the child perceptibly. The sloughs became very offensive, but there was no further bleeding from the wound for eighteen days, when a considerable quantity was lost. The child gradually sank, and died six weeks after the accident.

At the necropsy the common carotid was found to have been traversed by a sharp-pointed fragment. Behind the wounded vessel was an abscess implicating the sympathetic. Mr. Durham thought that if a ligature had been applied on the distal as well as on the proximal side the child's life would have been saved.

Another case of secondary hæmorrhage has been recorded by Mr Rivington (*Trans. Med.-Chir. Soc.*, vol. lxix. p. 63). This paper like several others by the same writer, is replete with valuable information and interesting facts. It is an excellent instance of the way in which the carotid may at any time be wounded from within, and not from outside, by a foreign body penetrating the pharynx.

A boy, aged 9, six days after swallowing a small plaice-bone, was admitted into the London Hospital with stiffness and tenderness of the neck, a small tender lump on the left‡ side opposite to the cricoid cartilage, profuse salivation, and inability to swallow solid food. On the ninth and the eleventh day hæmorrhage took place, on the latter occasion to half a pint. The following account of the operation by which the injured vessel was found and secured will be most instructive to every operating surgeon, owing to the difficulties which presented themselves.

An incision was made along the edge of the sterno-mastoid for several inches. The muscle was found glued to the subjacent parts by recent adhesions. Above the anterior belly of the omo-hyoid was a dark patch about the size of a fourpenny-piece, caused by extravasated blood looming through the fascia. The fascia over the large vessels being divided, a probe was passed down into a cavity containing clot, hollowed out behind the vessels and on the inner side. Owing to the uniform discoloration of artery, vein, nerves, fascia, and areolar tissue by the extravasated blood, the structures met with, being all dark and equally stained, could scarcely be recognised. The descendens noni could not be seen, nor the vagus distinguished, though carefully looked for. More clots being turned out from the cavity, in one of these the fish-bone was found. A gush of blood which took place, evidently from the distal end, was arrested partly by pressure and partly by pulling forward the vessels with a blunt hook. The wounded vessel being found, a ligature was passed closely, as was thought, around it, both above and below the seat of injury. Owing to the danger of subjecting the patient to a further loss of blood, there was no time to make a prolonged dissection, and it was thought prudent to divide the artery at the seat of the wound to make sure that no branch was given off between the ligatures. When this was done, some nerve-fibres were recognised on the cut section, and the question arose whether these were the descendens noni or the vagus. As they were in front of the vessel, closely adherent, and apparently scarcely numerous enough for the vagus, it was concluded that they belonged to the descendens noni, and no attempt was made to disengage the nerve or to unite its extremities. It was proved, later on, that this nerve was the vagus, which, instead of lying between and behind the artery and vein, took, or had been pressed into, an unusual position in front of the artery, and, owing to the inflammation induced by the injury, had become firmly adherent to the vessel for some little distance above and below the aperture in the artery. Externally the nerve was stained of the same dark colour as the artery, and only in the centre, after section, were the white nerve-fibres to be recognised. The patient died ten days after the operation, having shown no evidence of ill-effects from the divided vagus, save perhaps slight cough and difficulty in swallowing. Two gangrenous abscesses in the left half of the brain, which were probably already in progress prior to the operation, were the cause of death.

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* This would appear very doubtful, owing to the freeness of the collateral cerebral circulation, and the readiness with which a reflux current along the internal carotid is established.

† *System of Surgery*, vol. i. p. 739.

‡ The left common carotid is more exposed to danger in these cases from the passing of the œsophagus somewhat to this side.

(c) *Division of the Common Carotid* by gunshot injuries is usually fatal at once, as in two cases recorded in *Circular No.* 3 of the War Department, Washington, 1871.

2. In aneurysm of the carotid. When an undoubted* aneurysm of this vessel exists, and is increasing in spite of pressure,† or where this cannot be made use of, the artery should be tied, on the cardiac side of the aneurysm if possible, or, failing this, distally.

The mortality after ligature of the common carotid for aneurysm is as yet high. Thus Mr. Johnson Smith (*loc. supra cit.*), quoting from the tables of M. Lefort,‡ gives twenty-one as fatal out of forty-seven cases of proximal ligature. Mr. Barwell§ considers a little over 25 per cent. to be the mortality in cases of aneurysm proper. Whichever of these estimates is correct, in the future the mortality should be much reduced by the advantages of aseptic surgery and modern ligatures. **The chief dangers** to be guarded against are suppuration of the sac and hæmorrhage, brain and lung complications, and hæmorrhage from the site of ligature. These are alluded to more fully below, p. 596.

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* It is well known that this aneurysm is diagnosed more frequently than it is really found to exist, owing to the closeness with which a carotid aneurysm is simulated by some varicosity of the artery at its bifurcation, glandular and other tumours lying over it, and, in the root of the neck, other aneurysms—*e.g.*, of the innominate, aorta, and subclavian. Few surgeons will, I think, agree with the statement of Mr. Johnson Smith (*Dict. of Surg.*, vol. i. p. 235) that carotid aneurysm occurs "about as often as subclavian aneurysm, and with greater frequency than aneurysm of the axillary artery."

† This may be applied to the artery or the sac, or both. In the former case the artery should be compressed above the transverse process of the sixth cervical vertebra, to avoid making pressure on the vertebral at the same time. If pain, vertigo, sickness, &c., prevent a fair trial of digital pressure, an anæsthetic may be tried, but, as Mr. Barwell points out (*Encycl. of Surg.*, vol. iii. p. 498), there may be much difficulty in deciding how far the syncope, &c., which may be present are due to the anæsthetic or to the pressure. Another means of keeping up pressure on the common carotid is that suggested by Rouge, in which, the sterno-mastoid being relaxed, the surgeon insinuates his fingers behind one border and his thumb behind the other border of the muscle, and thus compresses the artery between them.

‡ *Gaz. Hebd.*, 1864 and 1868.

§ *Loc. supra cit.*, p. 503.

The old operation for carotid aneurysm is described at p. 594.

3. In aneurysm of the innominate or aortic arch. The question of the advisability of ligaturing the carotid, either together with the subclavian or alone, especially in the case of the left common carotid, is considered in the treatment of thoracic aneurysm.

4. In orbital aneurysm, where the symptoms are becoming aggravated, or where pressure has failed, or where it cannot be endured, even intermittently, for a few minutes only at a time, and where galvano-puncture and injection of coagulating fluids are set aside owing to their uncertainty and riskiness.*

Of fifty-three cases (Rivington, *loc. supra cit.*), viz., twenty-one idiopathic and thirty-two traumatic, in which the common carotid was tied, thirteen of the former were cured, and seventeen of the latter. The above writer, speaking of this mode of treatment, says it is "at present the most successful and satisfactory means of treating orbital aneurysm. It should not be practised on patients advanced in years, or on those with heart disease, or evident atheromatous degeneration of arteries."

5. In aneurysm of the external or internal carotid. These are very rare. Two cases of aneurysm of the former vessel have been published in recent years:

Mr. Morris (*Med.-Chir. Trans.*, vol. lxiv. p. 1) recorded one in which, after failure of ligature of the common carotid, the old operation of incising the sac was performed, and ligatures placed on the facial and lingual arteries, and upon the main trunk of the external carotid above the sac, with ultimate recovery.

The second case was published by Mr. Heath (*ibid.*, vol. lxxxiii. p. 69) in order to prove that ligature of the common carotid alone is sufficient to cure some cases of aneurysm of the external carotid.

The occurrence of aneurysm here in a woman, aged 23, was accounted for by the state of the cardiac valves and the liability for embolism to occur in consequence of detachment of a vegetation. There was a smooth, round, pulsating swelling just below the right mastoid process, reaching down to about the level of the upper border of the thyroid cartilage. It had the size and shape of half a small orange. The right tonsil was somewhat pushed inwards, the right temporal pulse was markedly weaker than the left, and the tongue deviated much to the right, the right half being a good deal wasted. The common carotid was tied, and the wound healed; pulsation in the aneurysm had stopped on the tenth day, and on the eighteenth the sac was smaller and quite hard. All seemed to be doing well till the thirty-third day after the operation, when loss of speech occurred somewhat suddenly, followed by right hemiplegia, and death on the thirty-fifth day, this being brought about by cerebral embolism taking place through the *left* carotid, the aneurysm being solidified throughout.

Aneurysm of the internal carotid is equally rare.

The following is a brief abstract of such a case (Dr. Wyeth, *Annals of Surgery*, August 1887, p. 114), in which the common and external carotids were tied, together with the superior thyroids, successfully.

The internal trunk was affected with atheroma to such an extent that the ligature could not be applied to this vessel. The operation was performed July 24, 1883. The tumour rapidly diminished in size, the patient leaving the hospital on the twenty-ninth day after the operation. She was living and well four years after the above date.

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* Mr. Rivington (*Dict. of Surg.*, vol. ii. p. 131) speaks thus of injection: "It is more painful than ligature, and probably involves more risk to vision, as it may set up inflammatory mischief in the loose areolar tissue around the veins, which may spread to the cornea. It may also effect so much coagulation as to interfere with the requisite supply of blood for the maintenance of the ocular tissues."

6. In hæmorrhage caused by ulceration of the throat after scarlet fever.

This is a rare but most dangerous complication of ulceration of the throat, and is usually brought about either by sloughing of the soft parts, or, as in the case mentioned below, by the opening of an artery or vein into an abscess cavity.

My old friend Dr. Mahomed communicated a case to the Clinical Society (*Trans.*, vol. xvi. p. 21) in which this complication occurred in a patient aged 21. Secondary sore throat, after an ordinary convalescence, was noticed on the fifty-fourth day, with much swelling on the left side of the neck, followed by severe bleeding (to 40 ounces) from the mouth on the fifty-eighth day. The left common carotid was tied by Mr. Pepper on the fifty-ninth day. Five and a half ounces of pus were brought up soon after the operation, and the swelling of neck and pharynx subsided, a good recovery ultimately taking place.

The common carotid was selected for ligature in preference to the external, since it allowed the operation to be performed quite clear of the infiltrated tissues, and thus conferred a greater immunity from secondary hæmorrhage. Moreover, had the original bleeding come from the ascending pharyngeal, ligature of the external carotid might have failed to arrest it, as the place of origin of the former vessel is variable.

The next series of cases, 7 to 11, may call for ligature of the external carotid rather than of the common trunk. With reference to them it must be remembered that ligature of the common carotid must be resorted to, not, as has too often been the case, on account of the greater facility with which this vessel can be tied, but only when the state of the patient or the condition of the parts, either primarily, from an anatomical point of view, or, later on, after secondary hæmorrhage, does not admit of tying the external carotid itself.*

7. In incised or punctured wound near the angle of the jaw.

In these cases, as in those below, a correct diagnosis as to the vessel or vessels injured is by no means easy when a sharp weapon has passed obliquely and deeply behind the angle of the jaw. By such a wound either the external or the internal carotid or some branches of the former may be laid open. A careful dissection can alone clear up the source of the bleeding, and, whenever it is possible, this should be resorted to; where the circumstances do not admit of this, the surgeon, relying upon the extreme rarity of injury to the internal carotid from its protected position,† will be abundantly justified in tying the external carotid. Ligature of the common trunk is less reliable, though, if resorted to on account of its simplicity, it may be defended by cases like those briefly alluded to by Mr. Le Gros Clark,‡ in which he successfully tied the common carotid for profuse arterial hæmorrhage due to stabs near the angle of the jaw:

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* In some of these cases the hæmorrhage may be arrested, and the dangers of tying the common carotid avoided, by the temporary closure of this vessel by a loop of stout catgut, applied as at pp. 593, 599.

† Mr. Cripps (*Med.-Chir. Trans.*, vol. lxi. p. 235) shows that, out of eighteen cases in which the bleeding vessel was identified, the internal carotid was found only to have been wounded twice alone, and once in conjunction with the external.

‡ *Lectures on Surgical Diagnosis, Shock, and Visceral Lesions*, p. 222.

"The injury was inflicted in the same way, and with the same form of instrument, in both instances—a pointed table-knife was plunged downwards and inwards behind the angle of the jaw. The bleeding was, in each case, controlled only by direct pressure with the fingers in the wound; and whilst this pressure was maintained I tied the artery. Not an untoward symptom accompanied or followed either of these operations."

On the other hand, cases of penetrating wounds near the angle of the jaw, ending fatally from hæmorrhage after ligature of the common carotid, will be found published by Mr. Travers (*Med.-Chir. Trans.*, 1827, p. 165) and Mr. Partridge (*Lancet*, 1864, vol. i. p. 659).

8. In punctured wounds through the mouth.

Here, too, the common carotid has been tied in some cases successfully, while in others this step has been followed by repeated hæmorrhages and death.

The following case may be quoted as an instance of the former result:

A child fell while holding the sharp end of a parasol in his mouth, the point being thrust forcibly to the back of the fauces and very nearly coming through the skin at the side of the neck. Considerable hæmorrhage occurred at once, and also about a week later. Ten days later a gush of arterial blood followed on coughing. The common carotid artery was tied, and the case ended successfully.*

On the other hand, cases ending fatally after ligature of the common carotid for hæmorrhage following punctured wounds of the mouth will be found recorded by Mr. Vincent,† Mr. Arnott,‡ and Mr. Morrant Baker.§

9. In hæmorrhage from carcinoma of the mouth—*e.g.*, tongue or fauces.

This subject is discussed at p. 580. It would be better surgery to tie the lingual in the case of tongue cancer, or, if the growth be farther back, to tie the external carotid and ascending pharyngeal, and only if this be found impossible, to ligature the common trunk.

10. In hæmorrhage after removal or incision of tonsils, or from an abscess about a tonsil.

These cases are infrequent, but, when they do occur, are, in a large proportion of instances, most dangerous. The sources of the hæmorrhage are very numerous, viz.—(1) one of the tonsillar arteries; (2) the tonsillar venous plexus; (3) the ascending pharyngeal; (4) the internal carotid. Hæmorrhage from the last two is much more likely to occur in suppuration in or around the tonsil than in wounds inflicted during operation on it.

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* The case was under the care of Mr. Johnson at St. George's Hospital. It is quoted by Mr. Durham, *Syst. of Surg.*, vol. i. p. 745.

† *Med.-Chir. Trans.*, vol. xxix. p. 38. In this case the bifurcation of the right common carotid had been punctured by a bit of broken tobacco-pipe from within the mouth. Sloughy cellulitis set in, and hæmorrhage took place from the mouth a week after the accident. This was arrested by ligature of the common carotid, but recurred on the second, and again, fatally, on the fifth day after the operation. Mr. Vincent points out that if the bit of tobacco-pipe had been discovered and removed, fatal hæmorrhage must have followed instantly, as the artery was not only wounded, but plugged by the foreign body.

‡ *Lancet*, 1854, vol. i. p. 135.

§ *St. Barth. Hosp. Rep.*, 1870, p. 173.

The following is a good instance (Mr. Pitts, *St. Thomas's Hosp. Reports*, vol. xii. p. 131) of a tonsillar abscess proving fatal from hæmorrhage:

A man, aged 39, was admitted with severe tonsillar abscess, which soon burst with the escape of a little blood. About 16 oz. were lost on the third day, bleeding again recurring on the fourth and fifth. The left common carotid was now tied; thirty hours afterwards 22 oz. were lost, and the patient died.

There was an abscess cavity around the left tonsil which communicated with the left internal carotid by an opening the size of the little finger nail.

Mr. Morrant Baker has recorded a case of suppuration around the tonsil dating to an injury.

Here the vessel injured was the ascending pharyngeal, but too short a time clapsed between the ligature of the common carotid and the death of the patient to say whether the operation would have been successful.

A man, aged 23, was admitted with symptoms of acute tonsillitis, the parts being tense, elastic, and prominent at one spot. A puncture was only followed by the escape of blood. The patient now gave a history of having fallen two days before, when drunk, and having grazed his throat with a clay pipe; this had been followed by very little bleeding. The temperature went up to 105°, and arterial hæmorrhage occurred on the third day after admission. A probe passed through the puncture showed that a considerable cavity existed; this was plugged with lint soaked in tr. ferri perchlor. The next day hæmorrhage recurred to half a pint; when ether was given, the bleeding again came on, nearly suffocating the patient. On exploring the cavity with a finger-tip, a bit of clay pipe was withdrawn; the cavity was again plugged and the common carotid tied. The patient died, without rallying, three hours later. A wound was found in the ascending pharyngeal artery.

Given a case of hæmorrhage from the tonsil (whether from a wound or an abscess) which resists other treatment, including well-applied pressure kept up with a padded stick inside the mouth and a finger behind the angle of the jaw, the surgeon should tie the external carotid as low down as possible, placing a ligature on the ascending pharyngeal as well, if this vessel can be identified. If the bleeding is from one of the tonsillar vessels it would be thus arrested, but in case the ascending pharyngeal is not secured, or the bleeding comes from the internal carotid, a loop of stout chromic gut as well should be placed under the top of the common carotid in the manner recommended by Mr. Rivington and Mr. Treves (pp. 593, 599).*

11. In hæmorrhage after operations on the neck or jaw. Hæmorrhage secondary to gunshot injuries.

In both these cases the parts may be so altered that it is quite impossible to find the bleeding point, and the soft parts may be so damaged, matted together, &c., that the surgeon may be driven to tie the common carotid, and to trust to this, and to plugging the wound, rendered as aseptic as possible, with strips of sterilised iodoform gauze,† and firm pressure over all.

12. To arrest the growth of aneurysm by anastomosis on the side of face, head, and neck.

The treatment of this condition is discussed at p. 599. It will be shown there that ligature of the external carotid cannot usually be looked upon as sufficient without other measures, owing to the free anastomosis between the branches of the opposite vessels. Still less is ligature of the common carotid likely to be successful, and this step should only be resorted to when ligature of the external carotid is impossible from the disease extending too low down; when, from its creeping towards the orbit, or to the back of the upper jaw, it is probable that there is a free anastomosis between the branches of the external and internal carotid through the ophthalmic; or when the ascending pharyngeal is sure to be involved, but this branch cannot be separately ligatured.

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* Every care should be taken throughout to keep the wound in the tonsil as aseptic as possible. As bearing on the use of iron perchloride as a styptic, see some remarks at p. 578.

† These may first be soaked in turpentine (p. 579) or formalin solution (1 in 250).

13. To arrest the growth of malignant tumours of the jaws which cannot be operated on, or which are recurrent.

This operation, first performed by Mott, is a very proper one in cases of malignant disease of the antrum, nose, &c., where the growth cannot otherwise be attacked and is increasing very rapidly, causing frequent bleeding, intense pain, and threatening to interfere with deglutition and respiration. The surgeon must be prepared for a good deal of sloughing, fœtor, &c., as well as shrinking in very vascular growths which have begun to fungate. In this case, also, it will be a question as to whether it is wiser to ligature both external carotids or the common carotid. The cases given at p. 603 may help here. If the common carotid is tied, the opposite external carotid should be ligatured also at the same time, owing to the free anastomosis, which will bring blood over from the opposite side. In any case it should be an operation to be performed at the patient's request after the matter has been explained to him, in the hope that its performance may lead to relief from the urgent local symptoms of the growth, and that life may be brought to a close, after an interval of relief, by increasing, but less painful, asthenia.

LINE.—From the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

GUIDE.—The above line, and the inner edge of the sterno-mastoid.

RELATIONS.—The common carotids, as far as their relations in the neck go, extend from the sterno-clavicular articulation to the upper border of the thyroid cartilage, along a line from the above joint to a point midway between the jaw and the mastoid process.

IN FRONT.

Skin; fasciæ; platysma; superficial branches of transverse cervical, and anterior jugular.
Sterno-mastoid, sterno-hyoid, sterno-thyroid, omo-hyoid; sterno-mastoid artery.
Superior and middle thyroid veins.
Descendens cervicis.
Anterior jugular vein (below).

OUTSIDE.	INSIDE.
Internal jugular (closer on left side).	Pharynx. Larynx. Trachea. Thyroid gland and vessels. Recurrent laryngeal.

Common carotid.

BEHIND.

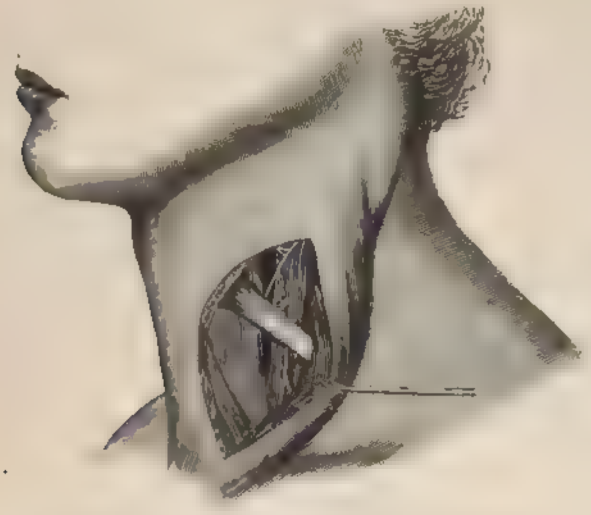
Rectus capitis anticus major.
Longus colli.
Sympathetic.
Inferior thyroid artery and recurrent laryngeal.
Vagus.

Operation.—Two sites are usually described, according as the vessel is tied above or below the omo-hyoid.

A. ABOVE THE OMO-HYOID (Fig. 215).—Also known as "the seat of election," owing to the greater facility with which this operation is usually performed.

The parts being cleansed, and shaved if needful, the shoulders are sufficiently raised, and the chin at first drawn a little upwards, while the head is turned to the opposite side,* so as to define the anterior border of the sterno-mastoid.† The surgeon, standing usually on the same side, makes an incision about three inches long, with its centre opposite to the cricoid cartilage, in the line of the artery, through the skin, platysma, and fasciæ, exposing the anterior border of the sterno-mastoid. Any superficial veins are now drawn aside, or tied, before

FIG. 215.



Surgical anatomy of the common carotid. (Maunder.)

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[*] Turning the head strongly to the opposite side should be avoided, as it brings the muscle over the artery. Mr. Barwell (*Encycl. Surg.*, vol. iii. p. 498) gives the following practical hint: "In certain aneurysmal cases (aortic and innominate) the etherised patient cannot breathe while his head is thrown back; the anæsthetiser is obliged to insist on bending it forward, and the operator has to get at the vessel under very trying circumstances, since in that posture it lies much deeper, and the ramus of the jaw is terribly in the way."

[†] Not always easy on the dead subject, or when the parts are infiltrated, as in Mr. Vincent's case (footnote, p. 588), or in Mr. Rivington's (p. 584).

division, with double catgut ligatures. The deep fascia at the anterior border of the sterno-mastoid is now divided, and the cellular tissue beneath opened up, usually bringing into view the upper border of the omo-hyoid, which, if in the way, is drawn down with a blunt hook, or divided. The edge of the sterno-mastoid is now drawn outwards, and the pulsations of the artery felt for just below the omo-hyoid.* In clearing the tissues which remain over the vessel, troublesome hæmorrhage may arise from the superior and middle thyroid veins, especially if the respiration be embarrassed; more rarely the sterno-mastoid artery is cut, and requires a ligature. The sheath is next exposed, and opened well to the inner side, avoiding the descendens cervicis, which usually lies to the front and outer side of the sheath.†

Other difficulties which may now be met with are an enlarged thyroid lobe overhanging the artery, or overlapping of it by the internal jugular when much distended. The coats of this vessel are so thin that, if it be much swollen, it is easily punctured, the result being that the wound is flooded with blood. It is best avoided by opening the sheath well to the inner side, but, if it still give trouble, it should be drawn aside with a blunt hook, or pressure should be made on it by an assistant, in the upper angle of the wound. If it should be opened, firm pressure should be made on this spot with a sponge on a holder, and the artery tied at a fresh place above or below. As soon as the ligature is tightened the hæmorrhage will cease, and firmly-applied pressure outside the wound for forty-eight hours will suffice to prevent any recurrence. If, after wounding the vein, attempts be continued to tie the artery at the same place, the wound in the vein is almost certain to be made larger. Other methods are to pinch up the wound in the vein and tie up the opening (if small) with fine carbolised silk or chromic catgut, or to leave on compression-forceps (p. 557).

The sheath having been opened well to the inner side with a careful nick of the knife, the artery is now cautiously and sufficiently cleaned, the inner edge of the sheath being held with forceps while this side of the vessel is cleaned, and then the outer in the same way, and, finally, the posterior aspect, the point of the director being kept most scrupulously in contact with the vessel here.‡ The needle is then passed from without inwards, being kept most carefully close to the artery, especially behind, so as to avoid including the vagus.

In this, as in every other artery whose relations are important, the fewer of these relations that the surgeon sees the more masterly and successful will his operation be.

In a deeply lying artery, in addition to relaxing the parts by flexing forward the head and depressing the chin, the sterno-mastoid must be drawn outwards and the larynx inwards with retractors, while the omo-hyoid is drawn downwards with a blunt hook or divided. The pulsation of the artery is then felt for, or, where this is feeble or absent, the rolling of the artery as a flat cord under the finger is made out.

B. LIGATURE BELOW THE OMO-HYOID.—Here the artery lies much deeper, and has the recurrent laryngeal nerve behind it; on the left side, the internal jugular vein lies very close to the artery; on the right, there is a distinct interval between the two vessels.

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* This muscle should be drawn downwards, or divided if needful.

† The position of this nerve is, however, very irregular.

‡ Opening the sheath on the inner side and cleaning the vessel properly are the two best safeguards against accidents.

The patient's head and the operator being in the same position as at p. 591, an incision three inches long is made in the line of the artery, from below the cricoid cartilage to just above the sterno-clavicular joint, exposing, as before, the anterior edge of the sterno-mastoid. This is drawn outwards, and, if needful, divided or detached below by making a short incision outwards along the clavicle. In this case the anterior jugular vein must be carefully looked for as it passes outwards in the root of the neck under the sterno-mastoid. The depressors of the hyoid bone next come into view; of these the sterno-hyoid, overlying the broader sterno-thyroid, is certain to be seen. If the omo-hyoid is coming up at this level, it lies external to the others. In such case it is to be drawn out while the other two are pulled inwards, any of the three being divided, on a director, if needful. At this stage one or more of the inferior thyroid veins may come into view, much swollen. The pulsation of the artery being felt for, or the flattened artery felt slipping beneath the finger when pressed upon, the sheath is to be opened well to the inner side, retractors usually being required at this stage. Care must be taken of the internal jugular, especially on the left side, as, if distended, it may conceal the artery.

When the carotid is sufficiently cleaned, the needle is passed from without inwards, avoiding the recurrent laryngeal nerve behind by keeping very close to the artery.

Temporary Ligature of the Carotid.—Mr. Rivington (p. 599) and Mr. Treves (*Lancet*, Jan. 21, 1888, p. 111) have drawn attention to this method, believing that the ligature of main arteries is resorted to too often, as there is sufficient evidence to show that in most cases it is only temporary arrest of the current that is required.

This method should certainly receive a further trial, on account of the risks of cerebral mischief after ligature of the carotid, and also because, as Mr. Treves says, pressure upon the carotid cannot be successfully maintained for a serviceable length of time.

The artery being exposed in the ordinary way, a thick piece of soft catgut is passed round it and tied in a very loose loop. By pulling on the loop, the blood-current is at once arrested, and restored when the tension is relaxed.

The following are abstracts of the four cases given by Mr. Treves:

1. Probable Wound of Superior Thyroid Artery.—A young man was admitted with a deep, profusely bleeding wound about the level of the great cornu of the hyoid. A fragment of glass driven in by a bursting soda-water bottle had been removed. The patient was blanched and almost insensible. It being "obviously useless to attempt to find the bleeding point while blood was welling up from so deep a wound," Mr. Treves placed a temporary ligature round the common carotid. Traction on this arrested all bleeding, and was maintained for half an hour. On relaxing the catgut, no hæmorrhage occurred. The loop was left *in situ* for four days, and then removed. The bleeding was supposed to come from the superior thyroid.

2. Hæmorrhage from Internal Carotid.—A child, aged 3, had profuse hæmorrhage from the right ear, and vomited blood. This recurred, and the right common carotid was ligatured, when the bleeding ceased. The next day hæmorrhage recurred, blood having evidently been brought round by the left carotid. As there is no case on

record* of recovery after ligature of both common carotids when the interval between the occlusion of the two vessels was less than some weeks. Mr. Treves simply placed a loop of catgut round the left carotid, and had traction made on it. The child never bled again, but sank exhausted six days after the second operation.

3. Hæmorrhage probably from External Carotid, after Impalement with a Spike.—A man, aged 41, fell twenty-six feet upon a railing-spike, which, entering just in front of the left ear, passed through the upper jaws, and entered the mouth through the hard palate on the right side. After removal of the spike, blood welled up freely from the wounds and nose. Traction made on a catgut loop passed round the left common carotid arrested this. A weak pulse could be felt in the temporal on the fourth day, and on the seventh the loop was removed. The case did well. It is not stated how long traction was maintained.

4. Hæmorrhage during an Operation.—In this case the loop was placed around the artery prior to removing a large malignant tumour of the neck. Very free bleeding occurred during the operation, but was always checked by traction on the loop. Without this the operation would have been very difficult.

Old Operation for Ligature of the Common Carotid.—This, one of the most formidable operations in surgery, was successfully made use of by Prof. Syme (*Observ. in Clin. Surg.*, p. 154) in a case of aneurysm the result of a stab.

The aneurysm, about the size of an orange, extended between the trachea and sternomastoid, and downwards close to, or rather under, the clavicle. Nearly at its centre was a cicatrix. It was increasing in size, and, other treatment having failed, it was decided to perform the old operation, it being evidently impossible to apply a ligature below the aneurysm.

"I pushed a knife through the cicatrix, and followed the blade with the forefinger of my left hand so closely as to prevent any effusion of blood. I then searched through the clots and fluid contents of the sac for the wound of the artery, and found that pressure at one part made the pulsation cease. Keeping my finger steadily applied to this point, I laid the cavity freely open both upwards and downwards, turned out the clots, and sponged away the blood so as to get a view of the bottom, which presented the smooth, shining aspect of a serous membrane, without the slightest indication of either the artery or vein that could be seen or felt. In order to make the requisite dissection, I next attempted to close the orifice by means of forceps, but found that it had the form of a slit, which could not be thus commanded. It was also so near the clavicle that pressure could not be employed below it, and, to my still greater concern, lay on the inner or tracheal side of the vessel, so that the compression required for its closure, instead of being backwards on the vertebræ. was outwards upon the vein. In these circumstances it seemed proper, so far as possible, to lessen the opposing difficulties, and I therefore ran a bistoury through the skin and the sternal portion of the sterno-mastoid. I then seized the edge of the slit in the artery, as it lay under my finger, with catch-forceps, and desired them to be held so as to draw the vessel towards the trachea; I then carefully scratched with the point of a knife until the arterial coat was brought into view at its external edge, a little above the aperture, where a ligature was passed by the needle, and tied. I repeated the same procedure below the wound, and, when it was completed, had the satisfaction of finding that my finger could be withdrawn without the slightest appearance of bleeding, instead of the tremendous gush which had previously attended its slightest displacement. The ligatures separated on the tenth day, and the patient recovered completely."

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* I am indebted to Dr. Simpson, Surg. Capt. Ind. Med. Service, for the following very interesting case, which has an important bearing on the above statement:—Case of Resection of Right Upper Jaw for Sarcoma, with Ligature of Both Common Carotids.—The patient was a Telugu lad, about 18 years of age, admitted into the Madras General Hospital while Dr. Simpson was acting as surgeon. Prior to the resection the right common carotid was tied with the view of diminishing the hæmorrhage at the operation. One week elapsed between the ligature of the artery and the removal of the jaw. During that interval Dr. Simpson and Dr. Smyth came to the conclusion that there would be no immediate danger in occluding the other common carotid, if need arose. Dr. Simpson began the operation (on the eighth day after ligature of the right carotid) by exposing the left common carotid at the level of the cricoid and passing a piece of elastic tubing round it. This was tightened gently and produced no effect upon the patient, who was well under the influence of chloroform. With the assistance of Dr. Smyth, Dr. Simpson removed the jaw, this being done almost bloodlessly. On relaxation of the tubing, sharp hæmorrhage ensued. In preference to attempting to arrest this, and thus causing much delay—a matter of great importance—a ligature was substituted for the tubing and the artery was tied. The patient made an uninterrupted recovery, and six months later was known to be in good health. There seemed danger at first of sloughing along the lines of separation of the jaw, and irrigation was constantly employed for the first two or three days. The case will be found published in *Trans. South Ind. Branch Brit. Med. Assoc.*, vol. v. No. 3.

Prof. Syme considered this by far the most arduous operation he had undertaken, from the fact that "the slightest displacement of one hand must have instantaneously caused a fatal hæmorrhage from the carotid artery, and a wrong direction of the needle by the other, to the smallest possible extent, would have given issue to an irrepressible stream from the jugular vein."

Sir J. E. Erichsen[*] gives the following graphic picture of the difficulties of the operation:

"The hæmorrhage having been completely arrested, either by compression of the artery above the tumour, or by pressure of the fingers at the opening leading into the tumour,[†] you lay it open freely and completely, turn out the coagula, and syringe away any dark or fluid blood which may be there. You then open the interior of the aneurysm. But what is that interior? It is not the interior of a smooth sac, but it is a large ragged cavity with masses of coagulum or solid fibrin sticking to it in different directions, with the remains, perhaps, of an old, sacculated aneurysm at the bottom, with a quantity of plastic matter infiltrating the tissues around it, with the anatomical relations of the parts utterly and completely disturbed and destroyed, with great thickening and solidification of the parts around from the pressure to which they have been subjected in consequence of the effusion of plastic matter. So you have a large cavity with an opening at the bottom of it, the opening leading to the artery somewhere or other, but the position of the artery more or less disturbed, more or less masked and obscured by these masses of coagulum, by this plastic infiltration, by this thickening and cohesion of the tissues to one another around it. The next thing is to pass the ligature around the artery. Now, the artery does not lie exposed in this sac; quite the contrary. You have to scrape, or to dissect, or cut through the posterior wall of this sac, which always overlies the artery. That constitutes the great difficulty of the operation—to open up this posterior wall in a proper direction, and to get the needle round the part without wounding the contiguous vein, or transfixing the artery, or doing damage to the neighbouring parts. The best way of doing that, undoubtedly, is to introduce a large steel probe or a metallic bougie into the opening into the artery, and to use that as a guide to the situation of the vessel. You may use a large one so as to plug up the opening.[‡] . . . . You then clear the vessel as well as you can—the coats are generally thickened and diseased in the vicinity of the aneurysmal tumour—and you pass a good double ligature around it."

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[*] *Lancet*, 1868, vol. ii. p. 505.

[†] Sir John thus puts Prof. Syme's practical point—"to make a small opening into the tumour, an opening just sufficient to enable you to insinuate your fingers, and so to work your whole hand gradually into the tumour in that way, so that the entrance of the hand may plug up the opening into the sac; to feel with your fingers for the opening into the artery, and to get your fingers against that, so as to restrain the flow of blood from it, before the rest of the sac is laid open."

[‡] In one case, as stated by Sir John, Mr. Birkett used a bougie as a guide.

Difficulties and Possible Mistakes during Ligature of the Common Carotid.

(1) Altered condition of the soft parts—*e.g.*, matted and œdematous from the close contiguity of an aneurysm, from a previous trial of pressure; or loaded with blood or inflammatory products, as in the case of a wound. (2) Presence of an aneurysm encroaching upon the incision. (3) Not hitting the edge of the sterno-mastoid. This muscle may be drawn over the artery if the chin be too much forced to the opposite side. The chin should be kept about midway between the acromion and the episternal notch on the opposite side (Barwell). (4) Great enlargement of the superior and middle thyroid veins.* (5) An enlarged and overlapping thyroid gland. (6) A large internal jugular overlapping the artery. (7) Opening the sheath towards its outer side, and so coming down upon, and perhaps injuring, the vein.† (8) Including one of the nerves‡ in relation with the artery—*e.g.*, the descendens cervicis, the vagus, or the sympathetic (p. 585).

Causes of Failure and Death after Ligature of the Common Carotid.

1. Cerebral complications—*e.g.*, impaired nutrition and softening. Sir J. E. Erichsen thinks that "cerebral symptoms" (he does not say whether he means fatal ones or no) are liable to occur in 25 per cent. of ligatures of the common carotid. They may come on almost at once, or some days after the operation. The same surgeon divides them into two sets—(1) the early ones, resulting from the too small supply of arterial blood, viz., syncope, twitchings, giddiness, impaired sight, and hemiplegia; (2) after the above have been present for a few days, and softening has taken place, convulsions and death ensue.§ It would be, perhaps, worth while, in view of the above mortality, to try pressure before resorting to the ligature, in order that the opposite vessels may

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* Mr. Barwell (*Internat. Encycl. Surg.*, vol. iii. p. 499) says that the superior thyroid vein, very full and turgid, sometimes runs before, more often behind, the carotid. "I suppose it is the effect of the anæsthetic which causes this to swell to the size of a cedar pencil."

† On the dead body, especially, there is a risk of mistaking the flaccid jugular for fascia, and opening it, unless the sheath has been opened over its front and inner part, as should always be the practice.

‡ "The descendens noni lies usually on the outer part of the sheath, and will rarely be endangered if that structure is opened as above described; but it is well to see that it is out of the line taken by the director; if its absence there be verified, it need not be hunted up elsewhere. The pneumogastric lies in the interval between the artery and vein in the back part of, but not loose in, the sheath; each of the vessels, as well as the nerve, has a compartment, strongly walled, to itself; while the sympathetic, behind the sheath, is also separated by a thick fascia from the vessels. If these anatomical positions be maintained, both nerves are saved. Young operators are sometimes made anxious and embarrassed by unnecessary cautions, yet sometimes the parts do not quite maintain their proper positions. Hence it is well, before tightening the ligature, to see that it includes the artery only."—Barwell (*loc. supra cit.*).

§ Mr. Barwell (*loc. supra cit.*) argues, from the fact that in no case of ligature of the innominate—an operation which cuts off all the right blood-supply—have cerebral symptoms followed, that there must be some other cause than brain anæmia for these complications: he thinks that a large majority of the cases in which so-called cerebral symptoms supervened from the seventh to the tenth day were cases of pyæmia, and that in some cases detachment of minute portions of clot may have been the cause.

become enlarged. Pressure could only be kept up, without an anæsthetic, for a few minutes at a time, and care would have to be taken not to apply it at the intended site of ligature. The temporary ligature (pp. 593, 599) also deserves trial. 2. Cellulitis and septic complications. 3. Recurrent pulsation. In most cases this is due to blood finding its way round from the opposite side. The pressure, however, in cases of aneurysm, having been relieved, coagulation, as a rule, takes place, though slowly. In a smaller number of cases the recurrence of the pulsation has been of a more permanent kind, from the ligature becoming loosened or dissolved, especially when catgut has been used. 4. Suppuration of the sac. Sir J. E. Erichsen states that this is not very uncommon. "In the majority of cases the patient eventually does well." 5. Hæmorrhage. This has never been a common complication, owing to the absence of branches. It may take place from the site of ligature* or from a suppurating sac. It should be still more rarely met with in the future, owing to the modern treatment of wounds. 6. Low forms of lung inflammation. The above authority states that these are not uncommon. He attributes them to diminished freedom of the respiratory movements owing to the disturbed circulation in the brain and medulla.

LIGATURE OF THE EXTERNAL CAROTID (Fig. 217).

This operation has not received the attention which it deserves, having been too often set aside for the easier operation of ligature of the common trunk.

Mr. Cripps,† discussing the ligature of the external carotid in the treatment of hæmorrhage from punctured wounds of the throat and neck, states that the **objections** raised to the above operation are:

1. The fear of secondary hæmorrhage from the seat of ligature due to the close proximity of its larger branches.

In answer to this he refers to M. Guyon's‡ collection of 27 cases of ligature of the external carotid, to which he adds 3. In only one case of these 30 did secondary hæmorrhage occur. Larger statistics than these have been furnished by Dr. Wyeth, of New York. He states that, of 67 cases in which the external carotid alone was tied, 3 died, and that all these fatal cases were from gunshot injuries in military practice. One of these fatal cases died on the table from the effects of hæmorrhage before the ligature could be applied. In the other two the cause of death is not given. Of the 67 cases, hæmorrhage occurred after ligature in 5, none of which proved fatal. In 4 of these the bleeding was noted as occurring at the seat of lesion beyond the ligature. The artery was tied on both sides in 2 patients, and both recovered.

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* This danger would seem to increase the lower down the ligature is placed. Mr. Barwell says that the only fatal case of secondary hæmorrhage he has had in this operation followed the ligature of a carotid with catgut close above the sterno-clavicular joint. It is not stated whether the wound was aseptic throughout or not.

† *Med.-Chir. Trans.*, vol. lxi. p. 234.

‡ *Mém. de la Soc. de Chir.*, vol. vi. According to Prof. Agnew (*Prin. and Pract. of Surg.*, vol. i. p. 636), out of nineteen cases of ligature of the external carotid only one proved fatal from hæmorrhage, and none from causes which could properly be attributed to the operation.

Dr. Bryant, of New York,* states that he can add 16 cases to the above 67, and that in only one of these did the subsequent death bear the least relation to the operation itself.

As stated at p. 605, the branches adjacent to the seat of ligature should be tied also.

2. The futility of the operation, should the wounded vessel be the internal carotid.

Mr. Cripps answers this objection by comparing the rareness of a wound of the internal carotid with one of the external or its branches.

He points out that, of 18 cases in which the bleeding vessel was identified, the internal one was wounded twice alone, and once in conjunction with the external.†

3. The external carotid is less easy to ligature than the common.

This objection will not weigh with a surgeon who knows his anatomy, and who is in the habit of operating.

The **advantages** of the operation are:

1. That the circulation through the brain is not in the least interfered with. Consequently, one large element of danger is avoided (p. 596).

2. The incision made over the external carotid can also expose the bifurcation and the internal carotid, and may thus lead to a direct exposure of the wounded vessel.

Indications.

i. Wounds of the Trunk and of its Branches.—This subject has been already alluded to (p. 587 *et seq.*). While it cannot be denied that the easier operation of ligature of the common trunk has answered in some of these cases, it has also certainly failed repeatedly. Considering the rarity of wounds of the internal carotid, the surgeon will do more wisely, in the case of a wound over the carotid area, to expose and tie the external carotid, low down in any cases of doubt, so that the trunk and the internal carotid may be exposed as well, if needful.

Mr. Rivington has recorded (*Clin. Soc. Trans.*, vol. xvii. p. 79) an interesting case of a wound of the external carotid by a stab in the parotid region giving rise to recurrent attacks of hæmorrhage, and treated successfully by temporary‡ ligature of the common carotid and ligature of the external carotid at the seat of injury.

A man, aged 31, was admitted into the London Hospital with three wounds, one severing the lobule of the left ear and passing into the parotid gland below the zygoma, a second behind the ear, and a third over the mastoid process. Hæmorrhage, occurring about a week later, was stopped by pressure. Erysipelas followed, and an abscess was opened in front of the ear. About three weeks after the accident, hæmorrhage again occurred, being brought on by a fit of coughing, blood running out from all the incisions. Though it was again arrested by pressure, Mr. Rivington judged, from the size of the stream and the force of the jet, that the injured vessel must have been the external carotid in the parotid gland.

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* *Ann. of Surg.*, Aug. 1887, p. 122. In this fatal case both external carotids had been tied to check the rate of progress of malignant disease of the lower jaw, floor of mouth, and tongue, which had been operated on repeatedly without success.

† Mr. Cripps' list is interesting to the surgeon. In the first ten it is to be presumed that ligature of the external carotid would have been the wiser course. In two the bleeding came from the external carotid; in one, the lingual; in one, the facial; in one a tonsillar branch; in one, a branch in the parotid gland; in two, the internal maxillary; in one, the inferior dental; in one, the middle meningeal; in one, the vertebral; in two, the internal carotid; in one, the external also was wounded; in one, the source was close to the bifurcation; in two, the common carotid, at the point of bifurcation, was wounded; in one, the ascending pharyngeal.

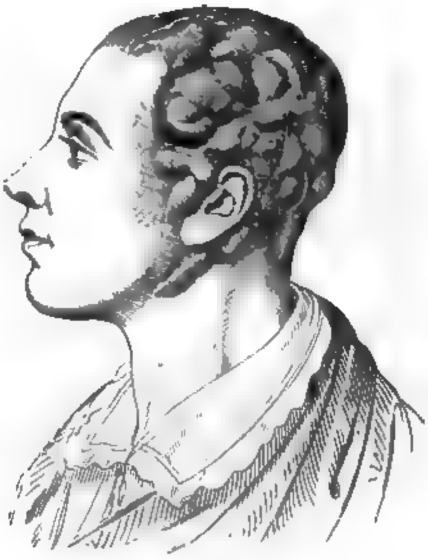
‡ Some cases in which Mr. Treves has more recently made use of this step are given at p. 593.

On account of the difficulty of securing the artery at the seat of injury, and the amount of blood which would be lost before this could be accomplished, and not being able to rely upon pressure on the common carotid during the operation, Mr. Rivington cut down first on the common trunk at its bifurcation and placed a temporary ligature of catgut round it,* tying this lightly so as to stop the current of blood, but not to divide the inner and middle coats.

The openings in the parotid region being explored and clots turned out, a little below the angle of the jaw was found a hole from which some blood issued in a feeble stream. The external carotid was ligatured above and below this spot. The ligature in the main trunk was then untied, and left *in situ* for use if needed. All bleeding had ceased, and there was no recurrence. The patient made a good recovery, some weakness of the face muscles having almost disappeared when he left the hospital.

Mr. Rivington draws attention to the advantage of the temporary ligature on the main trunk, rendered very evident by the fact that immediately before the operation, when the sponge was removed, arterial blood spurted out in a lively jet, whilst after the ligature a languid stream only issued from the distal side of the hole in the external carotid. He further points out that the employment of temporary ligatures, either lightly tied or left *in situ* for use in case of need, is capable of wider application in the treatment both of hæmorrhage and of aneurysms.

Fig. 216.



(Fergusson.)

ii. Aneurysm by Anastomosis of Scalp and Side of Head and Neck (Fig. 216).—Here the ligature of the external carotid should only be made use of as an adjunct to local treatment, or where this has failed.

If the growth is not too large, it should be excised with antiseptic precautions, tying each vessel as it is cut. The operation may be rendered partly, if not entirely, evascular by the use of stout india-rubber bands passed round the back of the head and the lower jaw, with pledgets of gauze over the main vessels—*e.g.*, temporal or external carotid, posterior auricular, and occipital. Another method is one made use of by Mr. Hutchinson in the removal of an enormous fibro-cellular tumour of the scalp—viz., a Petit's tourniquet passed around the back and sides of the head and the lower jaw (p. 191).

Where the above are not applicable, the external carotid may be tied preliminary to removing the tumour. When this is being effected, any skin that is not too much involved should be preserved. If this is impossible, the growth must be taken away, with the skin over it, the vessels being secured as cut. Every pains must be taken to keep the wound aseptic, and thus promote rapid granulation-healing, completed by Thiersch's skin-grafting (p. 188).

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* It remained uncertain whether this temporary ligature was placed on the external or the common carotid.

As these cases are most obstinate, my readers will excuse me if I draw their attention to other cases, proving that ligature of the external carotid (even if performed on both sides) is not likely to be successful without local treatment as well—viz., either under-running the vessels with pins, or excision. It is recorded by Dr. Bryant, of New York (*Ann. of Surg.*, Aug. 1887, p. 116):

The patient, aged 24, had a well-defined pulsating tumour at the site of a healed scalp-wound in front of the left ear. The trunk and branches of the temporal and the occipital were concerned in the growth. As this was rapidly increasing, the left external carotid was tied with catgut about half an inch above its origin. Tying the lingual artery also provided a branchless portion of the external carotid about an inch in extent. The ascending pharyngeal was sought for, but not found. All pulsation was at once checked, and the growth was also reduced to about one-third of its previous size. The operation was antiseptic throughout, and when the dressings were changed, for the first time in ten days, a slight return of pulsation was noticed in the tumour. A month after the operation, pulsation, thrill, and bruit were nearly as strong as before, and it was decided to attack the tumour itself in preference to tying the occipital and temporal branches, or the right external carotid. The arterial circulation was admirably controlled by surrounding the head with two strong rubber bands, beneath which compresses were placed at the points where arteries passed to supply the scalp. Arrest of hæmorrhage during operations on the scalp has been referred to at p. 191.

Dr. Bryant has found on record eight other cases of ligature of the external carotid for the cure of aneurysmal tumours of the head, face, and parotid gland, in two of which both the vessels were tied simultaneously. This latter procedure is not reported to have been successful in either case. Of a total of nine cases, only one, a traumatic aneurysm of the parotid, was cured by ligature alone.

Thus it would appear that local remedies—viz., excision and under-running, aided by ligature of the chief feeding arteries—are most likely to be successful in this disease, which so often baffles treatment. Ligature of the external carotid, on one or both sides, will fail, owing to the free collateral circulation, if tried by itself, even in recent traumatic cases without much general dilatation of the vessels. If used at all, it should be as an adjunct and a preliminary step to diminish the vascularity of the tumour before this is dealt with locally by the methods above indicated.

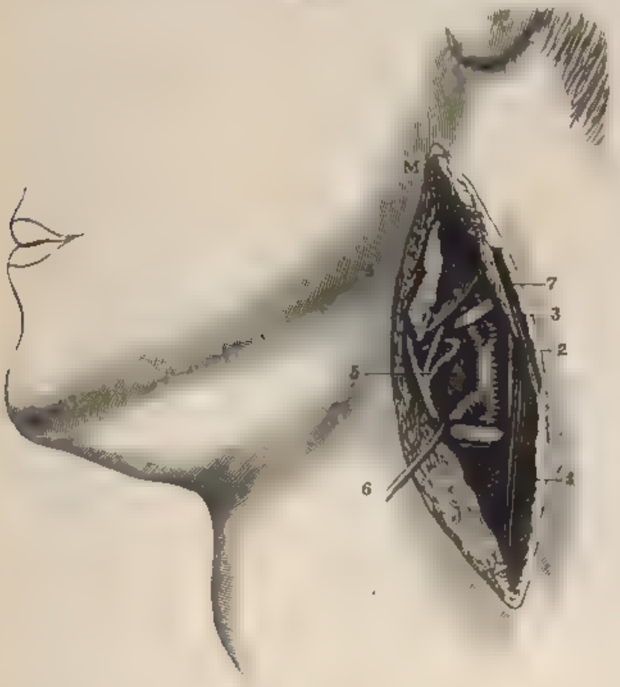
iii. Aneurysm of the External Carotid.—The treatment of this rare condition has been already discussed at p. 586.

iv. (A) As a Preparatory Step to Extirpating Malignant Growths of the Upper Jaw, Pharynx, &c., or (B) as a Palliative Step where the above extirpation cannot be attempted.

(A) As a **preparatory step** to extirpating malignant growths.—The external carotid may be tied before attempting to remove growths of the parotid, tonsil, upper jaw, angle of lower jaw, palate, or pterygoid region. The risk of secondary hæmorrhage is described at p. 473.

I have alluded at p. 446 to two cases in which I have resorted to this step—one in a sarcoma of the palate and pterygoid region, the other a case of epithelioma of palate and pterygoid region. The first patient was alive two years after the operation, but, as the glands were removed when he was operated on, success will probably not be permanently attained as in the second case. Four years have elapsed since the operation, and, as the disease was epithelioma, I am hopeful that the man is cured. He was seen in July 1900, quite sound and well. This year (1900) I have twice tied the external carotid before removing growths. One was a patient, æt. 66, sent me by Dr. Osborn, of Dover, with an ulcerating epithelioma on the inner aspect of the angle of the right jaw. The glands of the right sub-maxillary and deep cervical groups were also involved. Previous to removing the affected part of the jaw, the tonsil, and the glands, by an incision on the lines given at p. 473, I tied the external carotid. The patient died from gradual cardiac failure on the eighth day, and the necropsy, which proved that a fatty heart was the actual cause of death, also demonstrated the existence of a slough in the deeper part of the wound, so that, if the patient had lived longer, it is quite possible that secondary hæmorrhage would have supervened.

Fig. 217



Parts concerned in ligature of the left external carotid dissected.—M, Angle of the mandible. 1, Anterior border of sterno-mastoid. 2, Descendens cervicis. 3, Hypoglossal. 4, Posterior belly of digastric. 5, Lymphatic gland displaced from its position over the artery. 6, Venous trunk common to the superior thyroid, lingual, and facial, hooked downwards so as to show the spot to be chosen for the ligature, viz., between the origins of the superior thyroid below and the lingual and facial above. (These branches are drawn far too large.) 7, External jugular vein descending from the parotid gland in the upper angle of the wound. (Farabeuf.)

The second case was one of a girl of 16, on whom the late Mr. Davies-Colley had amputated through the lower third of the right thigh for a periosteal sarcoma of the tibia. The disease reappearing in the thigh, I amputated at the hip joint by lateral flaps, securing each vessel as they appeared (see section on Amputation at the Hip Joint). The patient made a good recovery from this operation, but three weeks later the left eyeball began to protrude, epistaxis ensued, and it was clear that a secondary deposit had invaded the orbit and was extending through the inner wall. I tied the common carotid on the left side to shut off the ophthalmic artery, and then the external carotid on the left so as to prevent the blood finding its way round so soon as to render the ligature of the common carotid unavailing. Mr. Hilton, the house-surgeon, then cleared out the orbit. This step, including the removal of the eyeball and the sarcomatous mass which was making its way through the thin inner wall, was attended with very little bleeding. The eyeball was then packed with sterilised gauze wrung out of formalin, one strip being brought out at the nose through the inner wall. The wounds in the neck healed by first intention, and the ligatures gave no trouble whatever. The patient died, four months later, of secondary growths in the skull, vertebræ, and pelvis. During this period the ligature of the above-mentioned vessels kept the epistaxis well in check.

(B) As **a palliative step** where removal of such growths as those alluded to at p. 590 is impossible. On this point I would refer my readers to the remarks already made at p. 590.

The following cases (Dr. Bryant, *Ann. of Surg.*, Aug. 1887, p. 121) are of interest as bearing on this matter. In each of these cases repeated operations had been performed for removal of malignant disease involving the lower jaw, floor of the mouth, and more or less of the tongue. Rapid recurrence had taken place in each case, until, the use of the knife no longer appearing feasible, the only course seemed to be starvation of the growth. Accordingly, this was attempted by simultaneous ligature of both the external carotids, by incisions in the usual place, the enlarged lymphatic glands found being removed. When the carotids were reached, most unusual anomalies were found. The right common carotid bifurcated beneath the posterior belly of the digastric, which was divided to admit of passing the ligature. On the left the bifurcation was behind the hypoglossal nerve, which was drawn down, and the ligature then passed just below the digastric. The lingual and facial branches were not seen on the right side, but this caused no apprehension, as the facial was said to have been tied some months before, during removal of the diseased sub-maxillary gland on that side. On the left side the branches of the external carotid were normal. The operations were antiseptic throughout. The malignant growth diminished in size rapidly, the discharge became scanty, thin, and watery, and the ability to speak and swallow improved quickly. On the fifth day a portion of the growth on the right side sloughed out, leaving an aperture bounded by sloughy tissue, at the bottom of which could be seen necrosed bone in the lower jaw. Nine days after the operation, profuse hæmorrhage took place, with a fatal result. This hæmorrhage was caused by sloughing of some of the diseased starved tissue, into which the trunk common to the facial and lingual passed.

In the second case no hæmorrhage or sloughing followed on ligature of the external carotids. For two months the state of the patient was much improved, the growth showed but little tendency to increase, and the pain and dysphagia did not return. Then profound cancerous cachexia set in, with emaciation and loss of strength, beyond which there is no note.

Excision of the External Carotid.—This method has been introduced in America to meet the objections which may accompany mere ligature of the artery, viz., secondary hæmorrhage if the wound unavoidably becomes septic, and, in the case of growths, the re-activity which sets in when the collateral circulation is restored. The following account is taken from Dr. Coley's article on "Cancer" (*Twentieth Century Practice of Medicine*, vol. xvii. p. 405): "R. H. M. Dawbarn, of New York, has originated a method of dealing with inoperable malignant tumours in regions deriving their blood-supply from the external carotid arteries, which he designates as 'excision of the external carotid arteries.' Attempts to starve malignant tumours by cutting off the arterial supply had previously been made, but never systematically.

Four years ago, J. D. Bryant, of New York, reported before the New York Medical Society a case of inoperable naso-pharyngeal sarcoma which apparently disappeared after ligature of both external carotid arteries, the patient remaining well nearly ten years afterwards. Bryant tried the method on a number of other similar cases, but the results were always confined to temporary shrinkage of the tumour. Dawbarn, reasoning from these results that the first case was successful because there happened to be present poor anastomotic connections, and that the other cases were improved at first but later became worse as soon as anastomosis developed, conceived the idea of *excising* the carotids. In a recent personal communication Dr. Dawbarn informs me he has carried out this procedure eleven times: in five patients on both sides, and in one on one side. The *final results* in Dawbarn's five cases are uncertain, since most of them are comparatively recent. One case is of special interest and importance. The patient was suffering from a round-celled sarcoma of the naso-pharynx. The growth was considered inoperable, and the mixed toxins of erysipelas and bacillus prodigiosus had been tried (thirteen injections) without apparent improvement. Both external carotids were then excised. The growth atrophied strikingly after operation; and Dr. Dawbarn writes: 'The patient is still living, and well, with his starved-out growth in place.' Such a result as this certainly merits further trials in cases of malignant tumour fed by the external carotid. Dawbarn believes that such growths cannot be 'starved' by merely ligating the carotids, inasmuch as there are twenty different ways in which anastomosis may occur if the arteries are only tied.

"The *technique* of the operation is as follows:—Ligate the external carotid just above its origin. Cut just above, and seize the upper cut end with stout artery-forceps. These hold the vessel as a handle throughout. Working upwards, tie off between two ligatures and divide each branch as reached. When the artery at length disappears into the substance of the parotid gland, use gentle traction on the artery downwards while *stretching* with a dressing-forceps a passage up into the gland. Avoid the knife here, to threaten facial paralysis as little as may be. At length one is able to slip a single ligature about the two terminal branches just above their origin—the internal maxillary and temporal—and to divide the end of the external carotid."

v. Hæmorrhage from Middle Meningeal Artery after Trephining.—This matter has been considered at p. 211, and more fully in *Guy's Hosp. Rep.*, vol. xliii., where it is shown that severe hæmorrhage is not uncommon after a wounded middle meningeal has been exposed by trephining, but that the bleeding will usually yield to measures short of ligature of the external carotid.

GUIDE.—The anterior border of the sterno-mastoid above the hyoid bone.

RELATIONS.—The external carotid extends from the upper border of the thyroid cartilage to a point midway between the external auditory meatus and the condyle of the jaw; beyond this point it is continued on as the temporal, having just before given off the internal maxillary. In the first part of its course the external is somewhat nearer the middle line than the internal carotid, and is more superficial than this throughout.

IN FRONT.

Skin; fasciæ; platysma; nerves from transverse cervical and facial; superficial veins.
Lingual and facial veins.
Digastric and stylo-hyoid.
Parotid, facial nerve; temporo-maxillary and other veins.

INSIDE.

Pharynx.
Hyoid bone.
Ramus of jaw.
Parotid.

OUTSIDE.

Parotid.
Temporo-maxillary vein, where this descends to join the internal jugular.

External carotid.

BEHIND.

Parotid gland.
Superior laryngeal.
Glosso-pharyngeal.
Stylo-glossus and stylo-pharyngeus.

The veins in relation with the external carotid vary a good deal. But, in addition to the lingual and facial crossing it, a number of veins joining the external and anterior to the internal jugular may form a kind of plexus round the artery, and the temporo-maxillary may descend outside the artery to join the internal instead of the external jugular.

BRANCHES:*

ANTERIOR.	POSTERIOR.	ASCENDING.	TERMINAL.
Superior thyroid. Lingual. Facial.	Auricular. Occipital.	Ascending pharyngeal.	Temporal. Internal maxillary.

Operation.—This is performed at two spots:
a. Below the digastric (Fig. 217).
b. Above this muscle, behind the ramus of the jaw.

a. **Below the Digastric.**—This is the operation more frequently performed in order to cut off the blood-supply through all the branches of the artery. Though these are so numerous, and vary somewhat, there is usually a spot, from one-half to three-quarters of an inch, between the superior thyroid and the lingual on which a ligature may be safely placed, especially if the superior thyroid and linguals be ligatured as well.

The position of the patient's head and that of the surgeon being the same as at p. 591, an incision three inches long is made, in the line of the artery, from the angle of the jaw to the upper border of the thyroid cartilage, about a quarter of an inch in front of the anterior border of the sterno-mastoid. This incision should divide skin, fasciæ, and platysma; any superficial veins being secured, the cellular tissue in front of the muscle is opened up, and the posterior belly of the digastric or the hypoglossal sought for as guides to the vessel. In doing this the sterno-mastoid should be drawn outwards, any large veins—*e.g.*, facial or lingual—pulled aside with a strabismus-hook or secured with double chromic gut ligatures before division. The muscle or the nerve being defined, the pulsation of the artery is felt for below them, and the vessel carefully cleaned just above the thyroid cartilage. The use of the steel director or knife should be most cautious on the outer side of the artery, where lie, below, the internal jugular and the internal carotid. At the same time the presence of the descendens cervicis on the artery is to be remembered, and that of the superior laryngeal nerve running obliquely downwards and inwards behind the vessel. The needle should be passed from without. The superior thyroid, facial, and lingual should be ligatured at the same time, and the ascending pharyngeal if it can be found.

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* While this is a common arrangement, it is by no means the only one. Very frequently one trunk gives off two or three arteries. Sometimes all the branches, save the two terminal, arise very close together, the external carotid constituting then an arterial axis. It is the presence of these branches which enables the surgeon to decide whether he is dealing with the external or internal carotid.

b. **Above the Digastric, behind the Ramus of the Jaw.**—This operation has the disadvantage of probably entailing the division of important branches of the facial nerve.

The head and shoulders being duly raised and supported, the surgeon makes an incision downwards from the tragus of the ear, just behind the ramus of the jaw, dividing the skin and fasciæ. The sterno-mastoid must now be drawn outwards, and the digastric and stylo-hyoid downwards, and it will probably be needful to divide these latter muscles partially in order to secure the artery before it enters the parotid gland, this structure being drawn upwards and forwards.

The needle may be passed from either side as is most convenient to the surgeon.

Several veins communicating between the facial and the external jugular will probably cross the line of incision, and must be dealt with.

LIGATURE OF THE INTERNAL CAROTID.

Indications.—These are extremely few.

1. Wounds, usually Stabs.—The following striking case is quoted by Dr. Lidell,[*] and reflects the greatest credit on the medical men concerned:

> On July 31, 1869, a man was wounded in the neck, at the angle of the lower jaw, by a knife, which penetrated several inches, opening the internal carotid. Alarmed by the tremendous outjets of arterial blood, Dr. Denning, in whose drug-store the stabbing occurred, at once compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it. Hæmorrhage now occurring from the upper end, was arrested by a ligature on the distal side of the wound. The patient was pulseless, and death was considered imminent, but, under energetic stimulation with whisky and ammonia, the circulation was soon restored, and the patient made a good recovery, being in active work nine years later.

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[*] *Internat. Encycl. of Surg.*, vol. iii. p. 111; *Amer. Journ. of Med. Sci.*, Jan. 1879, pp. 142, 143.

2. Aneurysm.*—If this be non-traumatic† in origin and sacculated, the decision as to treatment, if pressure have failed, must lie between the Hunterian operation of ligaturing the common carotid, or, if the artery be sound, and if there be room above as well as below the aneurysm, of placing ligatures above and below the sac, and opening this to turn out the clots. But one or both of the above conditions may very likely be absent.

If the aneurysm be traumatic, resulting from a stab or gunshot injury in the neck, or if, in spite of other treatment, it be steadily increasing, the only operation likely to avail is the old one.

The following cases are excellent instances of the difficulties which may be met with in these cases, and how they should be dealt with:

Dr. Prewitt, of St. Louis (*Trans. Amer. Surg. Assoc.*, vol. iv. p. 233), has recorded the following most interesting case of traumatic aneurysm:—A negress, aged 17, was shot with a revolver bullet, which entered the cheek over the malar bone and passed backwards. Profuse hæmorrhage took place at once from the wound of entrance, there being none of exit. This was controlled by pressure. A swelling quickly appeared between the ramus of the jaw and the mastoid process, which three months later was found to project into the pharyngeal cavity, crowding the tonsil over the middle line and resting against the uvula.‡ Externally the swelling reached from the temporal bone to the hyoid. Expansile pulsation, well-marked bruit, and thrill were present. Sense of taste was lost in the right side of the tongue, which was atrophied, and, when protruded, inclined to the right. Pressure on the common carotid arrested pulsation in the tumour, and caused some decrease in size. There was no perceptible difference in the right and left temporal pulses; the pupils were equal. There was persistent headache, and sometimes roaring in the right ear. Difficulty in swallowing had existed from the first. The general condition was unsatisfactory.

It was decided to tie the common carotid at once, but though the pulsation and thrill in the sac seemed arrested at first, they returned in a few minutes. It was then decided, as a forlorn hope (because the diagnosis had placed the opening of the sac close to the carotid foramen), to extend the incision upwards in front of the tragus to determine the feasibility of laying open the sac and tying the vessel upon the distal side of it.

A cautious dissection§ at the back and upper part of the sac showed that this filled all the space between the mastoid process behind and the condyle and ramus of the jaw in front, the sac seeming also to blend with the skull or to be closely adherent to it. A little reflection made it apparent that any attempt to deal with the sac after the method of Mr. Syme would in all probability prove disastrous, as it would almost certainly be found that there was no portion of the artery between the carotid foramen and the sac to be tied. The wound was washed out with bichloride solution, drained, and closed. On the evening of the eighth day, there having been pyrexia and free suppuration of the wound in the interval, hæmorrhage took place from the sac. The wound was enlarged, and search made with the finger for the orifice of the artery or the carotid foramen. The search being fruitless, and it seeming certain that laying open of the sac or removal of the finger would be followed by speedily fatal hæmorrhage, the sac was packed with strips of lint rolled in iodoform. Hæmorrhage did not recur, but the patient died exhausted twenty-five days after the first operation.

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* Aneurysm of the internal carotid here refers to the cervical part of the artery. The treatment of orbital aneurysm, which often depends on arterio-venous communication (traumatic or idiopathic) between the internal carotid and the cavernous sinus, has already been considered at p. 586.

† The rareness of disease, and thus of idiopathic aneurysm, here is well known.

‡ With reference to this tendency of internal carotid aneurysms to project inwards, Dr. Prewitt thus quotes from Prof. Agnew (*Surgery*, vol. i. p. 591): "The deep situation of the artery, covered as it is externally by the stylo-hyoid, stylo-pharyngeus, and stylo-glossus muscles, and by dense aponeurotic structures which extend down to the styloid process, prevents any very marked prominence of such a tumour on the surface of the neck, and, as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle, its extension inwards becomes an anatomical necessity. Indeed, in this peculiarity lies the chief difference between aneurysm of the internal carotid and aneurysm situated at the division of the common trunk."

§ It was suggested by Prof. Agnew, at the discussion on this paper, that the jaw should have been divided and the pieces pulled aside to facilitate further dissection; but Dr. Prewitt found that the jaw and sac were closely adherent, and, even if separation could have been effected, there would have been no artery above that could have been tied.

The necropsy was conducted under great difficulty, but it was thought that it was made out that the opening in the artery was close to the carotid foramen. Death seemed largely due to septic causes—*e.g.*, thrombosis of the inferior petrosal and lateral sinuses.

Dr. Prewitt points out that such an aneurysm might be mistaken for one of the occipital, vertebral, and perhaps of the internal maxillary or one of its branches. The chief diagnostic points are the projection into the pharynx; the evidence of pressure on the vagus and glosso-pharyngeal (p. 606); and the exclusion of the vertebral, by the effects of digital pressure below the sixth cervical vertebra (p. 608). He also shows by several cases that aneurysm of the internal carotid has repeatedly, owing to the interference with speech and swallowing, the pain in the neck, and the difficulty in opening the mouth, been taken for tonsillar abscess, and with fatal results. One of these cases may be quoted here:

A man, aged 28, was shot, on September 30, 1879, through the right infra-orbital region. No hæmorrhage. At the end of a week the swelling in the face had entirely subsided, but tumefaction of the right side of the neck remained. On the eighth day the patient was out. On the fifteenth he called at Dr. Lee's office, and complained of inability to speak or swallow, and also of severe pain in the right side of the neck, which he said he could not bend. His appearance was that of a man suffering from severe tonsillitis. With considerable difficulty Dr. Lee succeeded in opening the patient's mouth enough to permit of limited inspection. The tonsils and soft palate were so swollen as to preclude inspection of the pharynx. On the hard palate there was a small firm tumour about the size of a hickory-nut. Thinking this might be the ball surrounded by inflammatory products, an exploratory incision was made. On the removal of some clots of blood, there was a gush of arterial blood. In consequence of the struggles of the patient, Dr. Lee was unable to control the hæmorrhage, and death ensued in a few minutes.

In the discussion which followed on Dr. Prewitt's paper the following case of traumatic aneurysm of the internal carotid following a stab in the neck was related by Dr. Briggs, of Nashville:

A man, aged 23, had an expansile tumour in the left parotid region, encroaching on the throat, causing difficulty in swallowing. There was a loud bruit, and pulsation in the swelling was lessened by pressure on the common carotid. A small cicatrix pointed to the receipt of a stab six weeks before.

Acting on the principle that a traumatic aneurysm is simply a wounded artery, and should be treated as such, Dr. Briggs performed the old operation. A knife being pushed into the most prominent part of the swelling, this opening was plugged with a finger, which appeared to find the wound in the artery. The opening being enlarged upwards and downwards, large clots were removed, followed by a gush of arterial blood, which was arrested by stuffing the wound with sponges. The incision being prolonged downwards, the common carotid was tied. On the removal of the sponges, the hæmorrhage was as violent as before, and was only arrested by the pressure of a finger in the s[illegible]e this was kept up, the tissues were scratched through, and a ligature placed above and below the opening. Though the incision measured eight inches, there was scarcely sufficient room. At the bottom of the wound the styloid process could be seen, and just anterior and internal to it the ligatures on the internal carotid. The patient made a good recovery.

It will be seen that the two cases of Dr. Prewitt and Dr. Briggs differ widely. Though both were traumatic, in one there was room to place a distal ligature,* in the other there was not. The fact that, in the latter, hæmorrhage did not recur for the twenty-five days in which the patient lived after plugging the sac, leads one to hope that plugging with aseptic gauze, firmly and carefully, against the base of the skull, might be successful in such another case, if the wound could be kept aseptic, and the dysphagia met by tube-feeding.

LINE AND GUIDE.—These are practically the same as those given for the common carotid. The internal carotid lies at first outside and rather behind the external carotid. Soon after its commencement it becomes too deeply placed to admit of ligature.

RELATIONS IN THE NECK:

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid; stylo-glossus; stylo-pharyngeus.
Glosso-pharyngeal nerve.
Parotid gland.

OUTSIDE.		INSIDE.
Internal jugular.		Pharynx.
Vagus.		Ascending pharyngeal.
		Tonsil.
	Internal carotid.	

BEHIND.

Rectus capitis anticus major.
Superior laryngeal nerve.

Operation.—This is much the same as that for ligature of the external carotid. The artery can only be tied in its first and more superficial part. It here lies outside and rather behind the external carotid.

Thus the incision should be made along the anterior border of the sterno-mastoid, and not just in front of it, the centre of the incision lying about half an inch above the upper border of the thyroid cartilage. The sterno-mastoid being defined, and the cellular tissue opened up in front of it, the same superficial structures will be met with as in the external carotid (p. 604). When the carotids are found, the external should be drawn inwards, and the digastric upwards. The needle should be passed from without inwards, avoiding the internal jugular and the vagus.

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* Dr. Briggs, with reference to his case, stated that, though the opening in the internal carotid was very close to the carotid canal—not more than half an inch from it—the operation was not so very difficult.

LIGATURE OF THE VERTEBRAL ARTERY.

Indications.

(1) Wounds and (2) Traumatic Aneurysms may be considered together. There is liable to be much obscurity as to whether it is the vertebral or some other artery—*e.g.*, inferior thyroid, ascending cervical, common carotid, or, if higher up, the occipital—which is affected; and, when it is decided that it is the vertebral artery, it is by no means easy to carry out satisfactory treatment. The best course is to enlarge the wound, and to decide, with the finger, the relation of the wounded vessel and of the hæmorrhage to the transverse processes of the vertebræ. The direction of the wound, and the effect of pressure below and above the level at which the vertebral ceases to be compressible—*i.e.*, above the "carotid tubercle" (*vide infra*)—will also be helpful.

If the wound be low down, there are between two and three inches of the artery available for ligature, and this should be placed above and below the wound. But if, as is more frequent, the wound is higher up in the neck, it will be almost impossible, even after exposing and clipping away the anterior roots of the transverse processes, to find and secure the artery, and the best course will be to carefully plug the wound, as successfully done by Dr. Kocher, of Berne.[*]

A man, aged 48, had been stabbed in the neck. Daily hæmorrhages, often profuse, took place for three weeks, in spite of plugs of charpie soaked in perchloride of iron. On admission into the hospital a wound was found about an inch to the left of the spine, at the level of the fifth and sixth cervical vertebræ. Through the wound was seen a swelling, feebly pulsating. On removing coagula and opening up the wound, free arterial hæmorrhage came from a cavity about the size of a small apple, at the bottom of which transverse processes could be felt. The bleeding came from both the central and peripheral ends of the artery, between the transverse processes of apparently the fifth and sixth vertebræ. As a ligature could not be applied, a pea-like bit of charpie, soaked in solution of iron perchloride, was introduced between the transverse processes. The head was kept fixed with a stiff collar. On removal of the plug on the fourth day, partly with a stream of water, partly with forceps, no bleeding followed. The patient was discharged cured in five weeks, having had a slight attack of erysipelas.

Dr. Kocher states that Maisonneuve is said to have tied the vertebral and inferior thyroid arteries, and removed a bullet. The hæmorrhage was arrested, but death occurred from purulent infiltration into the spinal canal. This case appears to have been one of ligature of the artery before its entrance into the vertebral canal.

Aneurysms of the vertebral are always traumatic. There are about twenty-four[†] cases on record of aneurysms and wounds of this vessel. The situation varies much. Usually it is high up, near the mastoid process.[‡]

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[*] Langenbeck's *Arch. f. klin. Chir.*, Bd. xii. S. 867. A full abstract of the paper is given in the *Syd. Soc. Bien. Retr.*, 187–172, p. 202.

[†] Barbieri, of Milan, quoted by Kocher (*loc. supra cit.*), has collected sixteen; Pilz (Langenbeck's *Arch. f. klin. Chir.*, Bd. ix.) has gathered together four. Then there are Kocher's, one by Lücke in the same *Arch.*, Bd. viii. S. 78, and the American case given below.

[‡] In nine, according to Kocher, the wound was at or above the second cervical vertebra; in two, "at the upper part of the neck"; in six it was below the second

The difficulty of diagnosis of wounds of the vertebral and other arteries, and their results, has been already alluded to. Mr. Holmes (*Lancet*, July 26, 1873) states that there are eleven cases in which the carotid has been tied for wound or aneurysm of the vertebral, of course with no advantage. This mistake seems to have arisen from forgetfulness of the fact that, while pressure on the common carotid below the transverse process of the sixth cervical vertebra will check all pulsation in the carotid, the branches of the carotid, and aneurysms situated on them, it will also check pulsation in a vertebral aneurysm. Mr. Holmes points out that the above "carotid tubercle" is higher up than is usually supposed, being situated two to three inches above the clavicle, and he lays down the rule that, when a traumatic aneurysm is situated in the course of the vertebral, and its pulsations are commanded, however completely, by pressure on the common carotid low in the neck, it ought not to be treated as being carotid, or as affecting a branch of the carotid, until it is clearly proved that its pulsations are stopped by pressure applied above the level at which the vertebral ceases to be compressible —*i.e.*, above Chassaignac's carotid tubercle. Ligature of the vertebral artery in the first few inches of its course being so very rarely available, compression of the artery low down, with the aid of an anæsthetic if needful, and with the additional help of direct pressure or cold on the aneurysm above, should be made use of.

Dr. Weir (*New York Archives of Medicine*, 1884) records a case of a man stabbed on the right side of the neck, about three-quarters of an inch below the ear, just in front of the sterno-mastoid. A traumatic aneurysm, believed to be of the vetebral, slowly developed. Digital pressure over the carotid tubercle was made use of, and in three hours the tumour was cured.

If pressure fails, and if the aneurysm increases in size, the surgeon must decide between running the risk of injecting ergotine, or the use of coagulants, or opening the swelling and plugging it. In the latter case aseptic gauze strips—viz., iodoform or sal alembroth—should be made use of, in preference to the perchloride of iron. The gauze should be carried into the aneurysm, the wound being opened sufficiently freely to allow the surgeon to see what he is about, and the head should afterwards be kept rigidly still.*

(3) Ligature of the Innominate Artery, either at the same time to prevent secondary hæmorrhage, or, later on, to arrest this when it has occurred at the seat of ligature owing to the reflux of blood from the subclavian (p. 631).

(4) Epilepsy.—Dr. Alexander, of Liverpool, has performed this operation in thirty-six cases, after the first case usually tying both arteries simultaneously. The following (*Dict. of Surg.*, vol. ii. p. 786) is his opinion of the value of the operation:

The operation was performed in the hope that a diminution of blood to the hinder brain and the spinal cord would result in a lessening or cessation of the epileptic convulsions, it being expected that the diminution would be more permanent to the parts supplied after ligature

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cervical vertebra. In four of the latter it was in the neighbourhood of the external carotid artery and its branches; thus in one the wound was at the angle of the jaw.

* In one case related by Kocher the nerves lying behind the artery were injured, and in another, dangerous inflammation of the spinal meninges took place.

of the vertebrals than after ligature of other vessels, on account of the absence of anastomosing branches, and the restraints to dilatation of the unligatured vessels by the long canals through which the vessels pass. For a time these expectations were realised, but soon relapses occurred, and in May 1884 an analysis of thirty-six cases showed only eight cases which had had so few fits since operation that they might be practically considered cured. Eleven had been for several months so much improved that they seemed to be cured; and although the fits had recurred in all, yet the improvement was still distinctly manifest in many. In sixteen cases there did not seem to be any decided improvement. Three died out of the thirty-six—one from hæmorrhage, one from embolism, and one from pleurisy. All the cases operated on were chronic, hopeless epileptics, many of whom had become, gradually, mentally affected. Not one of the latter was permanently benefited to any practical extent. On account of the uncertainty as to what cases would derive benefit from the operation, Dr. Alexander had ceased to recommend or perform the operation. As far as he could then see, this chapter of surgery might be closed.

Relations.—The vertebral artery, the largest and usually the first branch of the subclavian, arises from the upper and back part of the artery, and ascends at first a little outwards and backwards to reach the foramen in the transverse process of the sixth (sometimes the fifth or the seventh) cervical vertebra. Traversing these foramina, it passes through that of the axis; it then bends outwards and upwards to reach that of the atlas, and, passing backwards, lies in a deep groove on the posterior arch of the atlas behind the articular process, beneath the sub-occipital nerve. In this position it lies in the sub-occipital triangle. Finally, it pierces the posterior occipito-atloid ligament and dura mater, and, running upwards and forwards through the foramen magnum, winds round to the front of the medulla to join its fellow and form the basilar at the lower border of the pons Varolii.

Behind.

Cervical nerves (in vertebral canal).
Sympathetic plexus.

Outside.
Scalenus anticus and phrenic nerve.

Inside.
Longus colli.

Vertebral artery.

In Front.

Internal jugular.
Inferior thyroid.
Thoracic duct (left side, crossing from within outwards.
Vertebral vein (often plexiform).
Sympathetic plexus.

Operation.—The head having been suitably raised and turned slightly over to the opposite side, an incision, three inches long, is made along the outer border of the sterno-mastoid, extending to the clavicle. In deepening this incision the external jugular must be looked out for, running parallel here with the outer border of the muscle. When the deep fascia is divided, the sterno-mastoid, together with the vein, is to be drawn inwards, the incision being prolonged along the clavicle, and some of the clavicular fibres detached from the bone if needful. The surgeon then, working with the narrow point of a steel director, carefully opens up the deep connective tissue, and endeavours to define the interval between the scalenus anticus and the longus colli muscles. As the outer border of the former muscle corresponds with that of the sterno-mastoid, this muscle must be well retracted inwards. In defining the vertebral artery as it lies between the scalenus and longus colli, the presence of the phrenic nerve lying on the scalene, the pleura internally, the internal jugular, inferior thyroid, and the vertebral veins over the vessel, with the thoracic duct crossing it, on the left side, from within outwards, must all be borne in mind, these structures being drawn to either side, as is convenient, with strabismus-hooks. The depth of the wound and venous hæmorrhage are difficulties at this stage. The needle is then passed from without inwards. Owing to the deep position of the artery a good light is essential, and the head must be manipulated so as to relax the deep parts as required. The anterior transverse tubercle in the sixth cervical vertebra is a good guide in cases of difficulty; below it, the pulsation of the artery should be felt. In cleaning the artery previous to passing the ligature, the fibres of the sympathetic must be disturbed as little as possible. Temporary paralysis from the interference with these fibres is almost certain, and immediate contraction of the corresponding pupil is of very frequent occurrence, and may be regarded as a pretty certain indication that the vessel has been secured. If the vertebral vein is wounded and cannot be secured separately, ligatures should be placed on artery and vein together, above and below the wound in the latter.

It has been suggested by Dietrich to tie the vertebral artery between the atlas and axis. This operation would prevent the reflux of blood from above after a wound or traumatic aneurysm below had been plugged; but, however feasible as a dissecting-room operation, it would be one of great difficulty on the living, owing to the depth and small part of the artery which is to be tied.

LIGATURE OF THE SUBCLAVIAN.

As it is very doubtful whether ligature of the first part is a justifiable operation even in these days of improvements in aseptic surgery and of new ligatures, the operations on the second and third parts will be described first, the two being taken together, as one operation is often only an extension of the other. The operation on the first part will then be more briefly alluded to (p. 621).

LIGATURE OF THE SUBCLAVIAN IN ITS SECOND AND THIRD PARTS (Fig. 218).

LINE.—From the curved and short course of this vessel no definite line can be given.

GUIDE.—The chief point to remember is the outer margin of the sterno-mastoid, as this corresponds to the outer border of the scalenus anticus, which has to be defined and then traced down to the tubercle on the first rib, the part of the artery to be tied lying on the upper surface of this bone, outside and behind the muscle and tubercle.

RELATIONS (third part):

IN FRONT.

Skin; fasciæ; platysma; branches of cervical plexus.
Venous plexus—viz., external jugular; supra-scapular; posterior scapular; transverse cervical; branch from cephalic.
Transverse cervical and supra-scapular arteries.
Cellular tissue and fat.
Nerve to subclavius.
Subclavian vein (below).

ABOVE.		BEHIND.
Omo-hyoid. Cords of brachial plexus.	Subclavian (third part).	First rib.

RELATIONS (second part):

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid.
Scalenus anticus.
Phrenic nerve.

ABOVE.		BELOW.
Cords of brachial plexus.	Subclavian artery (second part).	Pleura.

BEHIND.

Scalenus medius.

Collateral Circulation.

When a Ligature is applied to the Third or Second Part.—Three main sets of vessels* are here employed, viz.:

ABOVE.		BELOW.
The supra-scapular, The posterior scapular,	with	The acromio-thoracic, the infra-scapular, sub-scapular, and dorsalis scapulæ.
The superior intercostal, The aortic intercostals, The internal mammary,	with	The long thoracic and the scapular arteries.
Numerous plexiform vessels passing through the axilla from branches of the subclavian,	with	Branches of the axillary.

When a Ligature is applied to the First Part.—The collateral circulation may be carried on by the superior anastomosing with the inferior thyroid, one vertebral with its fellow, the internal mammary and superior intercostal with the long thoracic and the scapular arteries, and the princeps cervicis with the profunda cervicis (Smith and Walsham, p. 38).

Indications.

i. In some cases of axillary aneurysm—*i.e.*, those in which, owing to the pain, the irritability of the patient, the depth of the artery, or the rapid increase of the aneurysm, pressure is not available.* With regard to the operation of ligature of the subclavian for axillary aneurysm, it should be remembered that the mortality has been high. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 109) thus explains this fact: In the first place the procedure resembles Anel's operation almost as much as Hunter's. Hence, suppuration of the sac from the loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature must be placed in the immediate vicinity of large branches. Then, again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurysmal sac, and by the want of resistance in the parts which surround it. Sir J. E. Erichsen (*Surgery*, vol. ii. p. 212) also alludes to the unfavourable results after ligature of the subclavian for axillary aneurysm—*i.e.*, out of forty-eight cases, twenty-three were cured and twenty-five died,—and attributes the high mortality chiefly to three causes, viz.: (1) inflammatory changes within the chest; (2) suppuration of the sac; (3) hæmorrhage. (See below, p. 617, where the chief points in the after-treatment are given.)

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* Key, *Guy's Hosp. Rep.*, 1836. A case in which the subclavian artery had been tied for axillary aneurysm twelve years previously.

ii. Cases of subclavian and subclavio-axillary aneurysm not amenable to other treatment; or where the aneurysm, especially if subclavio-axillary, is small in size (not larger than a hen's egg), of recent duration, and distinctly traumatic in origin. Mr. Poland (*Guy's Hosp. Rep.*, 1871), in his report on subclavian aneurysm, gives nine cases of recovery and twelve cases ending fatally after ligature of the second or third portions of the subclavian for subclavian or subclavio-axillary aneurysm. With regard to the nine successful cases Mr. Poland raises a very important question. Was the aneurysm developed in a healthy artery? If so, the success is explained. In three the aneurysm was entirely local, independent of general arterial disease; in two this was doubtful; in four the origin was spontaneous. Whether general atheroma existed here must remain uncertain, as the patients recovered, and the artery, where tied, was healthy. "We can only say this: that subclavian aneurysm in its early stage, occurring in persons of the early or middle period of life, without any indication of disease of the heart or large vessels, may and does recover, and that a cure may be effected by means of a ligature of the third or second portion of the artery notwithstanding the disease is one of spontaneous origin, and therefore presumed to be indicative of arterial disease."

In these successful cases the size of the aneurysm in no instance exceeded that of a hen's egg, and the duration of the cases was short, being under four and a half months.

Of the twelve unsuccessful cases of subclavio-axillary aneurysm there was good reason to believe that in ten at least an atheromatous condition of the arteries existed. The size of the aneurysm was, in all save one, larger than in the first group.

iii. As a distal operation, together with ligature of the common carotid for some cases of aneurysm of the innominate and aorta. (See p. 643.)

iv. Preparatory to such operations as interscapulo-thoracic amputation (p. 177).

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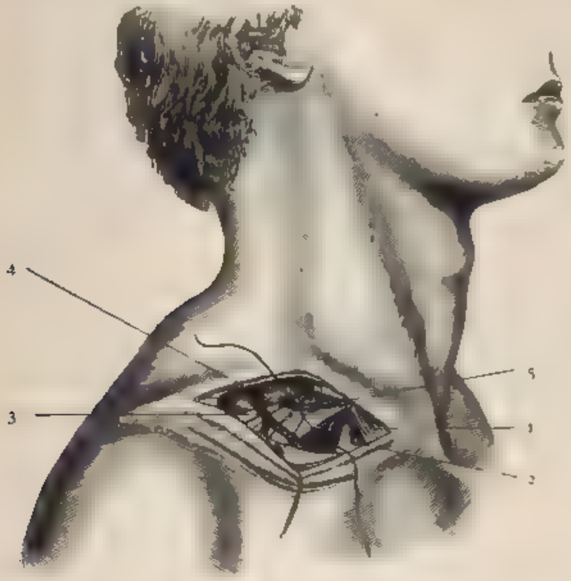
* See the conclusions on axillary aneurysm formulated by Mr. Holmes in his *Lectures at the College of Surgeons*, p. 107.

v. For wounds of the subclavian itself e.g., stabs. This is very rarely called for.

Operation for Ligature of the Third or Second Portion of the Subclavian (Fig. 218).—These two will be considered together, as one operation is but an extension of the other.

The patient having been turned over on to the sound side, propped up with pillows at the edge of the table, the head drawn over to the opposite side, the shoulder on the side of the aneurysm is depressed as strongly as possible, so as to open out the posterior triangle. The surgeon then, standing in front of the shoulder, draws the skin down over the clavicle with his left hand, and makes an incision, three inches long, over this bone, between the sterno-mastoid and trapezius, dividing skin, fasciæ, and platysma. The soft parts being now allowed to glide up, the incision should lie half an inch above the clavicle, the external jugular vein thus escaping injury; for, as this vein perforates the deep fascia just above the clavicle, it cannot be drawn down with the skin, superficial fascia, and platysma. If more room be required owing to the elevation of the clavicle or the presence of an aneurysm, the above muscles must be divided, and a longitudinal incision made upwards, at right angles to the inner end of the first, and a triangular flap raised outwards and upwards.

FIG. 218



Parts concerned in ligature of the third part of the subclavian 1, Sterno mastoid. 2, Scalenus anticus, below which the subclavian artery is seen deeply with a ligature passed below it 3, External jugular vein joining the venous plexus here met with 4, Omo-hyoid 5, Transversalis colli artery.

When the superficial parts have been sufficiently incised, the deep fascia is carefully opened at the inner end of the incision and laid open on a director, and the areolar tissue beneath, which varies much in density and in the amount of fat it contains, scratched through in a direction aiming for the outer edge of the scalenus anticus, which corresponds to the outer margin of the clavicular part of the sterno-mastoid. As soon as the deep fascia is divided, the presence of the following complications must be remembered and provided for. The soft tissues may be much matted, œdematous, and altered owing to previous use of pressure, or inflammation set up around a rapidly growing aneurysm. The venous plexus formed by the external jugular receiving the supra-scapular and transverse cervical veins, and, often, the posterior scapular and a branch over the clavicle from the cephalic as well, may be much engorged. Any one or more of these veins which are in the way should be drawn aside with a strabismus-hook or aneurysm-needle, or divided between two chromic catgut ligatures. Owing to the free anastomoses, this latter course is to be adopted without hesitation if needful. It cannot be insisted upon too strongly that a bloodless wound will best enable the surgeon to reach this often most difficult artery, and a bloodless wound is best secured by tying beforehand every vein which cannot be drawn out of the way, and by using a fine-pointed steel director as much as possible after the deep fascia is opened.

As a rule, the transverse cervical artery is above the incision, and the supra-scapular below it, under the clavicle, but occasionally one or both of these may be found lying across the field of operation, and must then be drawn aside with a strabismus-hook. While the veins may be ligatured without hesitation, the arteries must be preserved intact, that the collateral circulation may not be interfered with (p. 613).

The omo-hyoid varies in position, and may be neglected.

The outer edge of the scalenus anticus being defined by scratching through the cellular tissue, this muscle is to be traced downwards to the scalene tubercle on the first rib, immediately above and behind which landmark lies the artery. One of the lowest cords of the brachial plexus will now come into view, and is another good guide to the artery.

George A. Wright, of Manchester ("Case of Ligature of Subclavian Artery for Axillary Aneurysm," *Ann. of Surg.*, 1888, p. 362), emphasises the value of the lowest nerve cord as a guide in preference to the scalenus anticus and the scalene tubercle. In his case the muscle was not a very good guide, as "the tense fascia reaching from its posterior border to the sheath of the artery obscured the line of the muscle," and as the artery rose fairly high in the neck the tubercle was not of much value either.

This cord must not be mistaken for the artery, a contingency otherwise not unlikely to happen, as the lowest cord is in close contact with the artery and may receive pulsation from it.* A little cleaning will show the fasciculation of the nerve, where the artery is closer to the rib, and is flat, not rounded, when rolled under the finger.† By compressing the artery between the needle passed beneath it and his forefinger, and noting the result of this pressure on the aneurysm and the pulse below, the surgeon will clear up any doubts as to whether he has the artery or no.

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* Mistaking a cord for the artery, or tying the two together, has happened to excellent surgeons. Thus, in a case under the care of Mr. Green, of St. Thomas's Hospital, one of the cords was included in the ligature. The agony produced was extreme; the man did not cry out, but the expression of his face was something most appalling. The ligature was immediately loosed, and the artery alone tied, and all the frightful symptoms disappeared. The man made a good recovery, and was seen many years afterwards, perfectly well (Poland, *loc. supra cit.*, p. 83).

† Another difficulty about the pulsation is its variableness. Sometimes it is violent and excited; at others, as in the case of a dilated and diseased artery, or one much handled in the operation, almost imperceptible.

The position of the artery being made sure of, the sheath* is opened with the point of the knife, the artery cleaned, and the needle passed from above downwards and from behind forwards. This best avoids the worst risk—*i.e.*, of including a nerve cord. The needle should be kept most carefully close to the vessel, and not dipped suddenly or used with any force; otherwise the pleura or subclavian vein may be injured.†

The artery, before the ligature is tightened, will be inspected with some anxiety as to its condition—whether normal in size and structure, or dilated, thickened or thinned.‡ If much alteration be found, the surgeon should carefully divide the outer half of the scalenus anticus on a director with a blunt-pointed bistoury, keeping the wound absolutely dry so as to watch for the phrenic nerve, which, if seen, should be drawn inwards with a strabismus-hook.

If the artery be found diseased here also, the surgeon should use one of the ligatures described at pp. 626, 628, and endeavour so to adjust the tightening of the ligature as not to divide both the internal and middle coats.

In cases where the wound is a very deep one, care must be taken, while making the second knot, that the first does not slip. The ligature having been tightened and cut short, drainage is provided and the wound carefully closed and dressed. The limb is then bandaged with cotton-wool and kept somewhat supported, and the temperature maintained with hot bottles if needful.

The Chief Points in the After-treatment are—(i.) keeping the wound rigidly aseptic, (ii.) arresting hæmorrhage, (iii.) meeting suppuration of the sac, (iv.) combating the stiffness and weakness of the limb which sometimes follow on ligature of the main trunk.

(i.) This need not be further alluded to in a work like this, but it cannot be too strongly insisted upon that, if the high mortality (pp. 614, 620) which has hitherto attended this operation is to be reduced, it is mainly to keeping the wound aseptic throughout, and thus to early primary union, that we must look.

(ii.) The risk of hæmorrhage is so great that the surgeon should always endeavour to prevent it by trying to obtain early and firm closure of the wound, as just indicated, and by keeping the patient absolutely quiet till all is soundly healed. When once hæmorrhage occurs, the outlook is very grave. The treatment must vary according to the size of the wound which remains. If there be only a sinus, firm pressure must be made over the dressings by well-adjusted bandaging, aided by a heavy bag of shot or a truss-like instrument adjusted for the purpose.*

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* A process of deep cervical fascia which the vessel brings out from between the scaleni, and one which varies much in density.

† The surgeon should be provided with needles of different curves and a silver probe with a large eye. As pointed out by Sir W. Fergusson (*Surgery*, p. 607), with his attention to details in operations, the eye of the needle should always be close to the point, that the ligature may be at once seized with forceps as soon as it appears under the vessel, the difficulties at this stage of the operation being not only the surrounding parts of importance, but also the fact that in this case the handle cannot be depressed so freely as in operations on most other arteries, and thus it is difficult to make the point rise above the vessel.

‡ In a case of Liston's the vessel was dilated, thick, and soft, "aptly enough compared to the finger of a buckskin glove." The patient, aged 43, died of hæmorrhage on the fourteenth day. In a patient of M. Jobert's (Poland, *loc. supra cit.*, p. 110), "the vessel was found enormously large, equal to the size of an aorta; pulsation being very marked."

If the wound be larger, and perhaps septic and sloughy, an anæsthetic should be given, and. any clots having been removed, it must be rendered aseptic, and plugged with strips of sterilised gauze, the part placed within the wound having been wrung out of sterilised turpentine, and pressure applied as above. The patient should be kept as quiet as possible with morphia; the diet should be restricted and given at regular intervals, and without stimulants unless absolutely required. The cases collected by Mr. Poland (*loc. supra cit.*, pp. 116, 117) show that while hæmorrhage may occur as early as the eighth day, it may be deferred till the twenty-sixth or forty-sixth day, the ligature having come away on the twentieth day in either case. In neither of these two latter cases had the wound healed: in the first, the patient had been allowed to get up; in the second, pyæmia was present.

The above and the following remarks apply chiefly, of course, to the days when ligature of arteries for aneurysm was much more common, before the period of aseptic surgery and the employment of sterile ligatures.

The same writer (*loc. supra cit.*, p. 125) thus sums up the sources of hæmorrhage:

(*a*) *From the sac*, either *primary* from puncture during the operation, or *secondary* from ulceration or rupture at an early period, or later after inflammation and suppuration and giving way of the sac.

(*b*) *From the ligatured part*, in consequence of non-obliteration of the artery when the ligature is becoming detached, the hæmorrhage being generally from the peripheral end of the artery tied. It may be due also to an unsound state of the coats of the artery, such as dilated, thinned coats or atheromatous degeneration.

It is worth remembering that this hæmorrhage is, in exceptional cases, recovered from.

Mr. Poland (*loc. supra cit.*, p. 127) quotes four cases from the collection of Kocher which recovered after the use of styptics, pressure, and cold, and adds one under the care of Sir W. Fergusson (*Edin. Med. and Surg. Journ.*, 1831, p. 309), in which the hæmorrhage was arrested promptly and for good by pressure applied immediately by the patient's wife.

(iii.) Suppuration of the sac. The frequency of this untoward accident has been already alluded to (p. 614). It is due to the close proximity of the ligature to the sac, without any intervening branch, whereby the necessary coagulum is but ill formed and loose, acting as a foreign body, and liable to set up irritation, inflammation, and its consequences.

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* In a large hospital where relays of assistants are available, digital pressure may be made use of.

Every endeavour should be made to prevent its occurrence by forbidding all handling of the aneurysm.

If evidence of it occur, and the swelling, which has at first diminished in size, again about the second or third week steadily increasing in size, becomes tense and painful, but without pulsation, it must be opened by a sufficiently free incision, carefully emptied of pus and clots, drained, and well-adjusted pressure applied. If the wound have not healed, and particularly if it have become septic, hæmorrhage is extremely likely to occur after opening the sac—an ominous complication, which can only be met by plugging with aseptic gauze and using firm pressure (p. 618).

(iv.) Atrophy, stiffness, and weakness of the limb. These must be met by warmth, use of electricity, and, above all, by perseveringly-used massage.

The condition which is so common in the lower extremity after an analogous operation (see Ligature of External Iliac), in which the limb long remains in a state not far removed from gangrene, is much less common in the upper extremity.

Difficulties and Accidents which may be met with, and Points to avoid, during the Operation.

1. Sterno-mastoid and trapezius almost meeting.
2. A short full neck with much fat both above and beneath the deep fascia.
3. Clavicle much pushed up. This may be due to the patient having carried his shoulder raised to relieve the painful pressure on the nerves, or to the presence of an aneurysm.
4. The artery may be displaced.

This deviation from its usual course may be acquired, as in a case of Warren's (Poland, *loc. supra cit.*, p. 77), where the left subclavian was raised and displaced by a curvature of the spine in a woman, aged 30, the subject of an aneurysm (attributed to strain) about the size of a pigeon's egg, just above the scapular end of the clavicle. Ligature was performed by an incision made obliquely from the outer edge of the sterno-mastoid towards the acromio-clavicular joint, the pulsation of the artery being the guide.

Congenital deviations which have been met with are the artery perforating the scalenus anticus, or lying in front of it or, as usual, behind this muscle, but now closely accompanied by its vein.

5. The soft parts infiltrated, œdematous, or matted together owing to the presence and irritation of an aneurysm, aided, perhaps, by previous attempts at cure by pressure.
6. Great engorgement of the veins met with here, due to the presence of an aneurysm, and increased by the anæsthetic.
7. An aneurysmal sac very prominent and liable to be punctured in the operation.

This accident took place in the hands of the elder Travers. The sac was as large as a swan's egg, and pulsated strongly. The patient died on the third day after the operation, with effusion into the right pleura. The ligature was firmly seated on the artery at the root of the sac and adjoining the outer edge of the scalenus. The sac had a pouch-like enlargement upwards, which closely overlaid the artery on the pectoral side; and this, having been penetrated in the passage of the needle, had occasioned the profuse arterial hæmorrhage without saltus, which was not arrested by the tightening of the ligature, and which was only controlled by introducing a sponge tent into the wound. The same accident is stated by Sir J. E. Erichsen to have happened to Cusack while ligaturing the subclavian for a diffused aneurysm of the axillary artery.

The alarming gush of blood which took place was arrested by plugging the wound, but the hæmorrhage recurred fatally on the tenth day.

8. Wound of the supra-scapular artery necessitating ligature of this branch. As a rule this artery lies too low down to be injured—a complication to be extremely deprecated, as it is one of the chief channels by which the collateral circulation is established (p. 613). In about one out of every three cases the posterior scapular will be found to arise from the third part of the subclavian as a separate branch. Erichsen (*Surgery*, vol. ii. p. 208) advised, if this condition were met with, that the ligature should be applied, as far as possible, "to the proximal side of the branch. If necessity obliges the ligature to be applied close to the branch, it is perhaps safer to tie this also, as the anastomosis of vessels in this region is so abundant that the risk of gangrene from the obliteration of a single branch would be very small." But, according to the results of a necropsy in which Mr. Key had tied the artery twelve years previously for axillary aneurysm, both the posterior and the supra-scapular are very important channels by which the blood is carried into the axillary through the infra-scapular (*Guy's Hosp. Rep.*, 1836).

Any artery crossing the subclavian should be, normally, the transverse cervical. This or any other vessel which may be an artery should be drawn aside with a strabismus-hook.

9. Pulsation in the artery weak or deficient, or, on the other hand, excited and tumultuous (p. 616).

10. Including a cord of the brachial plexus (p. 616).

11. Injuring the pleura. This has happened on several occasions during the passage of the needle round the artery, owing to the close proximity of the serous membrane to the vessel, and the difficulty in passing the needle, especially when the clavicle is much raised, rendering it impossible to pass the needle from below, and thus away from the pleura.

Erichsen (*loc. supra cit.*, vol. ii. p. 212) considered inflammation of the contents of the thorax to be the most frequent cause of death, proving fatal in 1 out of every 2·5 cases. This is not pyæmic, but arises from causes essentially connected either with the operation or with the aneurysm itself. "These are referable to three heads. (1) Septic inflammation of the deep areolar tissue at the root of the neck may extend to the anterior mediastinum, the pleura, and pericardium. . . . . (2) The sac may, by its pressure inwards, encroach upon, and give rise to inflammation of, that portion of the pleura which corresponds to its posterior aspect.

"This occurred in a case in which Mayo, of Winchester, operated, and is more liable to happen if suppuration has taken place in the sac; when this occurs, adhesion may take place between this and the pleura, or even the tissue of the adjacent lung, and the contents of the suppurating tumour may be discharged into the pleural cavity or air tubes, and so coughed up. Of this curious mode of termination there are at least two cases on record—one by Bullen, in which the patient recovered; the other by Gross, in which the patient died from the escape of the contents of the sac into the cavity of the pleura.

"(3) Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the lungs; and although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurysm, yet it undoubtedly has occurred, as I have myself witnessed in one case."

12. Injuring the nerve to the subclavius, or including it in the ligature. This nerve, derived from the junction of the fifth and sixth cervical, usually gives a filament to the phrenic. If, as occasionally happens, this filament is replaced by a nerve constituting an important part of the origin of the phrenic, injury to it will be followed by urgent and speedily fatal dyspnœa.

13. Injury to the subclavian vein. This is rare, as the vein lies below and well away from the artery. But if ligature were called for in a case in which the vein accompanied the artery between the scaleni, this deviation would prove embarrassing.

I have spoken at p. 617 of division of the scalenus anticus if the surgeon does not find the part of the artery beyond this muscle healthy. It is not needful to speak at length and separately of this step, as it is a mere extension of the operation for ligature of the third part, the muscle being also only divided in part. Mr. Poland (*loc. supra cit.*, p. 128) points out that, of eight cases in which the scalenus was partially divided, five recovered, and that of these five recoveries the operation was on the left side. These cases thus fully prove that a ligature may be placed on the second part of the artery without fear of want of thrombus formation or of injury to important parts.*

LIGATURE OF THE FIRST PART OF THE SUBCLAVIAN.†

As this operation has been performed by surgeons of the highest eminence, and as it affords good practice on the dead subject, it will be given here. It seems most doubtful, however, whether the improvements of modern surgery aided by recently introduced ligatures will ever render this a successful operation, failing as these advantages almost certainly will to meet that secondary hæmorrhage which has proved so fatal from the distal side of the ligature, owing to the facility with which the numerous collaterals bring in blood to this spot.

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* As shown by Mr. Poland, the remarks of Porter on the numerous and great perils of this operation are scarcely borne out—viz., the phrenic on the scalenus anticus; the thoracic duct lying, on the left side, at the inner edge of the muscle; the three large branches usually given off by the subclavian while between the scaleni; and the close proximity of the first dorsal nerve behind the artery.

† These remarks refer to the right subclavian. A ligature has certainly once been placed on the first part of the vessel on the left side, Dr. Rodgers, of New York, being the operator, and losing his patient from hæmorrhage on the fourteenth day. Sir J. E. Erichsen (*loc. supra cit.*) states that Sir A. Cooper failed in an attempt to secure the vessel, and that he is said to have wounded the thoracic duct. See also Sir W. Mitchell Banks' remarks, p. 636.

Sir J. E. Erichsen, who gives what he calls an "appalling" table of fourteen cases, all fatal, condemns the operation as "bad in principle" and "most unfortunate in practice," and considers that it should "be banished from surgical practice."

RELATIONS.—These, owing to the greater depth of the artery on the left side, must be given separately.

IN FRONT.

Skin; fasciæ.
Sterno-mastoid; sterno-hyoid; sterno-thyroid.
Internal jugular and (often) vertebral vein.
Vagus; phrenic; cardiac nerves.

Right subclavian (first part).

BEHIND.

Recurrent laryngeal; sympathetic.
Longus colli; pleura (and beneath).

IN FRONT.

Sterno-mastoid; sterno-hyoid; sterno-thyroid.
Pleura; lung.
Vagus; phrenic; cardiac nerves.
Internal jugular; innominate veins.
Common carotid.

OUTSIDE.

Pleura.

Left subclavian (first part).

INSIDE.

Trachea.
Œsophagus; thoracic duct.

BEHIND.

Sympathetic.
Œsophagus; thoracic duct.
Longus colli.

Operation.—This resembles ligature of the innominate. The following account is taken from Mr. Barwell:*

A triangular flap having been turned upwards and outwards, and both heads of the sterno-mastoid divided, the anterior and, if needful, the external jugular veins are secured with double chromic-gut ligatures, and divided. The fascia over the sterno-hyoid being exposed, "the director, after a little opening in the aponeurosis has been made, can be insinuated behind that muscle, which also must be severed. It is well now to look and feel for the carotid artery before going on to divide the sterno-thyroid, whose outer edge covers that vessel, and never, as far as my experience of the dead subject goes, conceals the subclavian."† The finger of the operator, after division of the sterno-hyoid, readily detects the longitudinal course and pulsation of the carotid, and may with ease push the edge of the sterno-thyroid from off its sheath inward, in which position the muscle should be held with a blunt hook. When the sheath of the vessel is thus brought into view, the operator should look for the large veins that always, but more especially if there have been dyspnœa, overlie it. Choosing a vacant spot, he merely nicks the loose structure in which they lie, and then pushes them up and down, tearing the cellular tissue a little, till the dense fibrous sheath is bared sufficiently, first, to have a small opening made in it, and then to be slit up. This should be done on the front and inner aspect. Now, at this part the vein diverges a little from the artery, so as to leave a triangular interval, through which the vagus runs. A blunt hook is placed over this, and it is to be drawn with the jugular vein gently outward. The next point is to find the subclavian. To do this the operator must remember that the usual description and delineation of the innominate bifurcation is incorrect. It is generally depicted as if the two branches rose side by side and almost at right angles to each other. In reality, the subclavian springs behind the carotid, and the angle between the two vessels is very acute. Therefore, to detect the subclavian, the operator must place his finger at the back and outer part of the carotid, when, passing it down, he comes, generally a few lines above the clavicle, to the slightly divergent pulsating line of the subclavian, which lies deeper than the carotid by the whole diameter of that vessel.

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* *Intern. Encycl. Surg.*, vol. iii. p. 513.

† "The mere division of the muscle is in itself unimportant, but there lies behind it a plexus of large veins, passing from the thyroid body to the internal jugular, generally distended by the dyspnœa accompanying aneurysm at the root of the neck. Their division causes profuse bleeding, and subsequent difficulty in recognising the deeper parts."

In selecting the spot for placing the ligature, it is well not to put it quite close to the bifurcation, but also not too near the scaleni, lest the recurrent laryngeal or the phrenic should be injured. The vagus and the jugular vein should be kept, not too forcibly, outwards, and the needle should be passed from below, while with his left forefinger the surgeon gently presses the pleura downwards and outwards. Some obstruction behind the artery will very likely be encountered, but it is better gently and patiently to overcome this, and never on any account to attempt to pass the needle the other way; for if this be attempted, the instrument is certain to penetrate the pleura. Having now passed and tied the ligature, the surgeon should consider the advisability of also securing the vertebral. It lies in the groove between the longus colli and scalenus, so that the jugular vein must now be held inwards; the dissection already made will have so nearly exposed the artery that a few touches with a director will lay it sufficiently bare to allow the passage of the needle. The position of the phrenic nerve on the anterior scalene, outside and a good deal in front of the vessel, guards it against much risk of injury, but still it must be carefully avoided. The operator must not mistake the inferior thyroid (which is, however, much smaller, and usually at this part external) for the vertebral* itself.

LIGATURE OF THE INNOMINATE.

There have certainly been over twenty cases, and in only about five have the patients survived.

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* "In certain cases the aneurysmal sac overlying the vertebral artery renders it inaccessible."

One of these is the well-known case of Dr. Smyth's, of New Orleans (*Syd. Soc. Bien. Retr.*, 1865-6, p. 346), which occurred before the days of antiseptic surgery. The second, under the care of Sir W. Mitchell Banks, has never been published. I am enabled, through his courtesy, to give this case below, p. 635. A third successful case of ligature of the innominate has been published by Dr. Lewtas, of the Indian Medical Service (*Brit. Med. Journ.*, 1889, vol. ii. p. 312). While this case, most creditable to the operator, shows what skill and coolness can effect in a terrible emergency, and while it proves that a catgut ligature in a healthy innominate will withstand the force of the blood coming *a tergo*, it must be remembered that the subclavian aneurysm here was a traumatic one, and the patient only 20.

A month before his admission a piece of the breech of a bursting gun had lodged above the right clavicle. A swelling, about the size of a fœtal head, occupied the lower part of the posterior triangle, hard to the touch and not pulsating. From a partially healed wound brownish blood had been oozing for three days. As the man was anxious for removal of the foreign body, and as the case seemed to be one of deep cervical suppuration, the opening was enlarged sufficiently to admit the little finger, and a fragment of steel, weighing three drachms, removed with dressing-forceps. This was followed by an alarming rush of blood, so profuse as to render impossible discovery of the bleeding point. Fortunately the finger detected the opening in the subclavian behind the scalene, and by pressure an assistant thus arrested the hæmorrhage. The man's condition being desperate, it was decided to tie the innominate and carotid. This was done by an incision along the inner border of the sterno-mastoid and notching the sterno-hyoid and sterno-thyroid. The two vessels were secured with catgut ligatures. A drainage-tube was inserted into the extensive cavity of the original wound, some of the coagula which filled this being removed. The patient made a good recovery.

Mr. Coppinger (*Trans. Royal Acad. Med. Ireland*, vol. xi., 1893, p. 243) briefly mentions a case in which he successfully tied the innominate for a large subclavian aneurysm. The variety of ligature used is not stated.

Another brilliantly successful case, and one most encouraging to the surgeon, was under the care of Mr. C. J. Symonds. It has not yet been published, and I am indebted to my colleague for the following notes of the case:

G. McCann, aged 53, was admitted, October 1894, for a subclavio-axillary aneurysm. The most prominent part of the sac was just below the clavicle. The whole of the supra-clavicular space was filled, and the pulsating swelling extended backwards under the trapezius to the scapula. It was just possible to limit the swelling at the border of the sterno-mastoid. Fearing that the artery would be unhealthy in its second part, it was decided to attempt to ligature the first part of the subclavian, and if this proved difficult, or impossible, to secure the innominate. On November 5 a vertical incision was made between the two heads of the sterno-mastoid muscle, and without much trouble the first part of the subclavian was identified. On attempting to pass the needle, a short sharp gush of blood occurred, which stopped on withdrawing the needle. A further dissection of the artery was made, but again, on passing the needle, the hæmorrhage was repeated with greater force. Pressure of the finger stopped it at once, and, though the pressure was removed, the hæmorrhage was not repeated. As apparently some large branch of the thyroid axis was injured, it was decided to ligature the innominate. The sternal head of the sterno-mastoid was, therefore, divided, and an incision made in the median line. Thus, there were two vertical incisions joined by a transverse one along the inner third of the clavicle. The sterno-hyoid and thyroid were divided, and subsequently sutured with catgut. The common carotid was easily reached, and surrounded with a silk ligature. Slight traction was made upon this: the beginning of the subclavian was identified, and then the innominate brought into view. This was secured by a silk ligature and the wound closed. The muscles were sutured with chromic catgut. The ligature was of stout floss-silk. After a few days two openings appeared, one over the inner end of the clavicle, and one in the first vertical incision. Through both of these several pieces of catgut came away, and one piece of silk. The man made otherwise an uninterrupted recovery, the pain rapidly disappeared, and the aneurysm became quite hard. When seen in June 1895, the usefulness of the hand and arm were gradually returning; the aneurysmal sac was hard, but still obvious. There was no pulsation in the brachial or radial. Pulsation could be felt in the carotid above the ligature.

Dr. H. L. Burrell published (*Boston Med. and Surg. Journ.*, Aug. 8, 1895) a carefully reported case of ligature of the innominate for a fusiform aneurysm of the right subclavian and innominate. As in this case death occurred from cardiac collapse (the heart being dilated and hypertrophied), three months after the operation, the wound having healed seventeen days after the operation, it must be considered a successful one as far as surgery and the operation go.

The following points are of much interest:—(1) The inner end of the clavicle, the sterno-clavicular joint, and the right half of the notch of the sternum for about an inch, were removed (p. 634). (2) The fusiform aneurysm of the subclavian and carotid extended on to the innominate itself, sufficient space being left to place a ligature between this fusiform extension and the aorta. Two ligatures of flat-braided silk were used.* The first was placed three-quarters of an inch from the aorta. Both were tied in "square knots." Fully three minutes were taken in tying the first ligature, this being gradually tightened until the circulation was completely cut off. The second ligature was placed, in the same manner, half an inch higher up. As each ligature was tightened the coats were felt to give way. At the necropsy the innominate showed an extreme degree of endarteritis. The artery was occluded by the upper ligature; by the lower one it was severed, consecutive healing along the line of severance having taken place. Continuity of the lumen of the artery had followed here, and the ligature was found within the vessel, probably covered by a thin layer of the intima. While the fusiform aneurysm had shrunk, very little clot had formed at the site of ligature. For this reason Mr. Burrell, in another case of fusiform aneurysm in this situation, would tie the carotid, if possible the subclavian in its first part, and, if practicable, the vertebral.

It is noteworthy that the operation took an hour and a half, and that though the patient, with general arterio-sclerosis and a dilated and enlarged heart, was under the influence of ether all this time, no ill-effect followed.

The extreme danger of the operation is due partly to difficulties which may be met with at the time of its performance—difficulties which have driven most skilful surgeons to abandon the operation—but chiefly to the frequency of secondary hæmorrhage.

In an operation which must be performed at such long intervals it will be some time yet before we know how far modern antiseptic surgery is able to diminish the above mortality, with the absence or diminution of suppuration, the more rapid healing, the firmer thrombosis, and the improved ligatures. Lord Lister, speaking of antiseptic ligatures in 1869, wrote thus sanguinely: "For my own part, I should now without hesitation undertake ligature of the innominate, believing that it would prove a very safe procedure."

Two other cases have in late years been fully reported—viz., Mr. Thomson's and Mr. Bennet May's. In spite of all the care taken, and the use of modern ligatures, neither of these cases ended successfully. Mr. Thomson's patient died on the forty-second day, of hæmorrhage, which began on the thirtieth day. It was believed that the sinus which resulted from the drainage-tube became septic, and that the pus had ulcerated into the innominate at a point quite unconnected with the ligature, the latter (ox-aorta furnished by Mr. Barwell) having disappeared. Mr. May's patient died of secondary hæmorrhage on the nineteenth day, caused by the large and very hard knot, which had been tied in the ligature used, ulcerating into the vessel (p. 627).

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* Two ligatures are considered necessary, "one to act as a breakwater by obstructing the constantly recurring waves of blood coming from the aorta."

Two more cases, given in detail below, must be added to the above: Sir W. M. Banks' case, with death from hæmorrhage on the thirty-seventh day after ligature of the first part of the subclavian, subsequent to ligature of the innominate (p. 627), and my own, fatal on the tenth day from exhaustion brought on by incessant restlessness (p. 637).

The question which *ligature* is best suited to a large trunk like this, very likely diseased, with blood possibly impelled into it by the closely adjacent heart, and with collateral circulation certain to be quickly set up along the carotid and vertebral, has been much discussed, but Mr. Symonds' successful ligature of this vessel with silk has gone far to help us on this point. And not only this question, but others which arise with it are still awaiting answer, viz., *the tightness with which the ligature should be tied*, and *the advisability of using a drainage-tube*. With regard to the former, numerous cases, especially those of Mr. Barwell, have proved that, if ox-aorta or kangaroo-tail be properly prepared, their contact with the soft tissues they surround will be unirritating, and that, infiltrated by wandering cells, they wil be gradually absorbed, new rings of fibrous tissue forming in their place. Mr. Barwell's cases of ligature of the carotid and subclavian for innominate aneurysm have also established these points—(*a*) that ox-aorta may be so tied as not to divide the inner coat;* (β) that this ligature may produce as permanent and complete obliteration as any silk ligature. Sir W. M. Banks' case (p. 635) also encourages the further use of these ligatures, as kangaroo-tail tendon was used in this, the first case in which a patient has recovered without hæmorrhage after ligature of the innominate for non-traumatic aneurysm. I am of opinion that the above cases fairly prove that these ligatures, if properly prepared and tied with sufficient tightness, are free from any tendency to slip prematurely or lose their hold from the knot becoming soft or untied, an objection which could fairly be brought against the catgut ligatures when first re-introduced some years ago. I do not think that another objection brought against them by Mr. Holmes is a valid one: "Mr. Barwell's ligature is, no doubt, flat when laid on a table, but when tied it is hard to see how its sharp edges can be prevented from impinging on the vessel, and if they do they will probably cut the middle coat." With all due respect to such an authority, and speaking only from an experience of two vessels, the innominate and the carotid (p. 637), I think the extreme suppleness which half an hour's soaking in a tepid solution of hyd. perchlor. or carbolic acid brings about in these ligatures removes any risk of "sharp edges." But whether this is sufficient sterilisation (these ligatures do not admit of being boiled) is, to my mind, more than doubtful. When tying such a vessel as the innominate the surgeon must have several ligatures reliably sterilised, as their breaking is still an accident to be prepared for.

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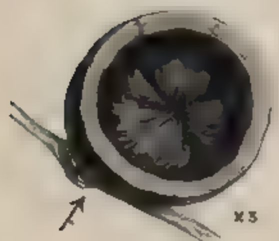
* It is right to point out that another case of the same surgeon proves that, in attempting not to divide the inner coat, the surgeon may fail to close the vessel at all.

Thus in Mr. May's case the needle—an old-fashioned silver one, flexible, well rounded at the point, and with a large eye—having been passed satisfactorily round the vessel, "was threaded with a small cord to which a strip of ox-aorta material, kindly sent me by Mr. Barwell, was attached, and by it pulled through. In tightening the tape, I had to draw the ends with very considerable force to stop the pulsation, the vessel offering great resistance and pulsating with great force. Just at the critical moment, however, the material gave way and broke across, and a second piece introduced in a similar manner suffered the same fate. I then endeavoured to imitate the principle of the flat ligature by using a cord made up of five or six medium-sized threads of catgut. This bore the strain very well, and, after tightening with sufficient force to completely stop pulsation in the tumour and branches of the carotid, I drew on the ends still further to allow of some subsequent relaxation in fixing the knot. At the same time I endeavoured to avoid crushing the coats of the artery. The ligature was secured with a third knot, and cut short." The patient died of hæmorrhage on the seventeenth day, and it was found that this very precaution, taken with all care and thoughtfulness by Mr. May, had tended to bring about the fatal result. "The ligature still retained a firm hold on the vessel; one or two of the threads were partially absorbed and softened, but others scarcely changed. The knot, unfortunately very large and hard, was quite unaltered. Under the knot, in the front of the vessel and in the line of a fold or bend of its wall, was the obvious source of the hæmorrhage, in the form of a ragged hole about the size of a small pea; this opened into the vessel on both sides of the ligature." Mr. May goes on to say that the further appearances were instructive in view of the debatable questions surrounding the use of animal ligatures. With the exception of the hole corresponding to the knot, no part of the arterial wall was injured or divided, though under the ligature itself the wall was thinner than elsewhere. The inner coats were intact. It was obvious that the small chink which remained between the crumpled-up folds of the vessel, the remainder being occluded by adhesion of the inner coats, was closed by a moderately firm clot. A similar clot with conical end extended along the distal side of the artery nearly to its bifurcation. On the heart side there was a thin diaphragm of clot with a conical end, but extending a very inconsiderable distance. As the bulk of the hæmorrhage no doubt occurred here, some of the clot may have got carried out during life. The hole in the wall of the artery having been closed, it was shown, by injecting water, that the vessel was wholly occluded at the seat of ligature.

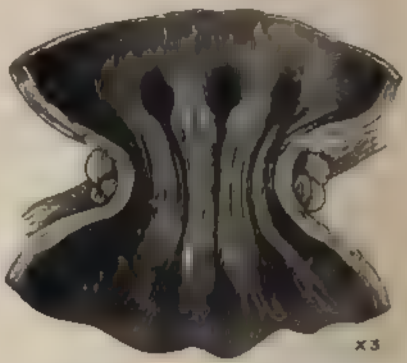
Turning from the results which bedside work has given, to those of experiment, we are struck by the diametrically opposite conclusions at which workers have arrived as to the most useful form of ligature and the best means of tying it. This, though at first embarrassing, will be of less importance to those who, like myself, hold that any evidence drawn from ligature of arteries in animals is of little value when applied to those of man. It is not only that (as we have daily opportunities of seeing) wounds and injuries in animals heal more readily and with much less risk of sepsis than in man, but evidence drawn from ligatures of *healthy* arteries in *healthy* animals must be received with much caution, the difference being very wide indeed between these cases and those where a ligature has to be applied in man for an aneurysm, in patients past middle life, and with vessels no longer sound. Finally, anyone who has tied the innominate in man for aneurysm will hesitate to accept conclusions drawn from ligatures of like material, and tied in like manner, on the carotids of sheep and horses. In addition to the objections already given, the two wounds are totally different. In the case of ligature of the carotid in animals we have a vessel which can be tied in healthy parts, well known for the rapidity with which they heal, and a wound which can be made with very slight disturbance of the soft parts. In the innominate, on the other hand, we have an operation beset with difficulties, often involving, from the presence of an aneurysm, much displacement of parts, and a wound, from its position with its deepest part behind unyielding bone, most difficult to drain efficiently. I have spoken above of the diametrically opposed results at which those who have worked at the experimental side of this question have arrived. This is shown by the papers of Mr. Ballance and Mr. Edmunds, "The Ligation of the Larger Arteries in their Continuity: an Experimental Enquiry" (*Med.-Chir. Trans.*, 1886, p. 443); "Ligation of the Great Arteries in Continuity, with Observations on the Nature, Progress, and Treatment of Aneurysm" (1891); and Mr. Spencer's "Experiments on Ligature of the Innominate" (*Brit. Med. Journ.*, 1889, vol. ii. p. 73).

FIG. 219.



Artery ligatured with kangaroo-tendon (× 3), without rupture of its coats, to show the folds into which the wall of the artery is thrown by a kangaroo tendon ligature when the coats are uninjured. Transverse section made immediately above the ligature; there are three main folds, the middle or largest of which is under the knot.

FIG. 220.

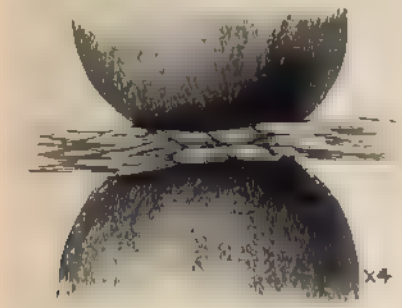


The same artery opened out by a longitudinal incision passing through the knot and the artery wall beneath it. The arrow in the left figure indicates the line through which this incision was made. The knot is seen cut in two, and the folds of the artery wall are exposed, the largest being divided and the halves turned aside. Each fold has secondary folds, indicated by the longitudinal lines on their surface.

(Ballance and Edmunds.)

The first-named writers have arrived at the following conclusions: (1) That the operation of ligature of a large artery in its continuity should be performed without damage to its wall. (2) That the rupture of the coats of an artery during ligation in continuity is a useless and dangerous proceeding: useless, because the surgeon can secure the effectual occlusion of the vessel by a measure at once safer and less severe; and dangerous, on account of the possible occurrence of hæmorrhage or secondary aneurysm at the seat of ligature, which could not happen if the wall of the vessel were uninjured by the ligature. (3) That, if the artery be diseased, the advantages attending ligation without rupture of the tunics are much magnified. It sometimes happens that the surgeon, on cutting down upon a large artery, observes a state of atheroma so extensive that he is obliged to close the wound and ligate a vessel nearer the heart, and thus expose his patient to considerably increased risk. There is no escape from such a dilemma under the system which declares that the arterial coats must be divided; but with a non-irritating aseptic ligature, so applied as not to lessen the power of the arterial wall, but actually to be a source of additional strength to it, the question of ligation is seen under entirely new auspices, and the occlusion of a diseased artery would be undertaken with an assurance of success almost equal to that which obtains when a healthy vessel is in question. (4) That, when the coats of an artery are uninjured by the ligature, the danger of ligation near a large collateral branch is wholly avoided, because—(*a*) No danger can accrue from hæmorrhage when the wall of the vessel is intact; (*b*) The formation of clot, upon which the safety of the patient so much depends if the wall of the vessel be damaged, has really nothing to do with the adhesive changes which take place in a ligatured vessel; (*c*) The plastic actions which proceed at the place of ligation are practically alike, whether the tunics be ruptured or not. (5) It would appear that a small round antiseptic ligature which will not become absorbed in less than three weeks, and which during that period holds firmly so as to cause a constriction of the arterial wall, and complete, or almost complete, obstruction of the cavity of the vessel, will so influence the nutrition of the part that permanent occlusion will follow. It is pointed out that by the use of two ligatures a greater length of the intima of opposite sides is brought into contact. (6) That it is no more necessary to use a flat tape-shaped ligature (as recently revived by Mr. Barwell to prevent damage to the arterial coats during ligation) than to rupture the coats of the vessel. The small round ligature is the most easy to manipulate, [illegible] not difficult to learn to apply it in the manner here indicated. [illegible] book [illegible] *cit.*), published in 1891, the above writers express a

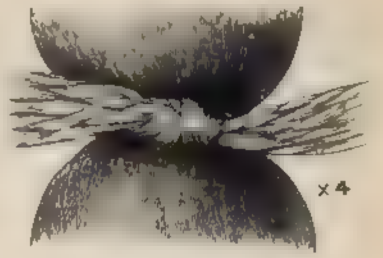
FIG. 221.



Floss silk
Stay knot first stage

Represents two floss-silk ligatures side by side (× 4). The first half of a reef knot is tied on each in the same way. The two ends on either side, being treated as one, are drawn upon to occlude the vessel. The hitches lie at the bottom of a deep groove, and are seen to fit into one another.

FIG. 222.



Floss-silk
Stay knot (completed).

Shows the knot completed by using the two ends on each side as a single cord, and by tying the second hitch as if completing an ordinary reef knot. The ligatures may also be tied separately.

(Ballance and Edmunds.)

decided preference for kangaroo-tail tendon, as it is readily made aseptic, strong, of ample length, easily rendered as supple as silk by soaking it in tepid sublimate solution, and employed as in Figs. 221 and 222. Speaking to me on the subject in August 1900, Mr. Ballance expressed his preference for such a ligature duly sterilised.

Mr. Spencer, from his results of ligature of the innominate in monkeys, also advises silk, concluding that the best ligature is one of Chinese twist silk which has been kept in 5 per cent. carbolic acid, and boiled in that solution before being used. A silk ligature can be thus "rendered more thoroughly aseptic than any other without injuring its strength, and, being aseptic, it will remain quiet in position without relaxing. The ligature should be tied tight to divide the internal coats." Mr. Symonds' successful case in which a silk ligature was used encourages the further use of this material.

A third very interesting paper was read by Dr. Delépine and Mr. Dent before the Medico-Chirurgical Society, May 26, 1891. Its title, "The Changes observed in Healthy Arteries and in Tendon Ligatures during the First Four Weeks after Ligation," limits the deductions to be drawn from it as a guide in dealing with the human innominate. The authors advocate a tight ligature with division of the inner coats. It is clear from the above papers that a healthy artery may be tied by either method successfully if aseptic precautions be adopted. As long as there is such a wide difference of opinion as to the mode of using the ligature the surgeon should keep an open mind in dealing with an artery like the innominate, according to its soundness or the reverse. In the case of an artery which is diseased, I think the balance of evidence is in favour of a ligature—either tendon or floss-silk, if duly sterilised—tied tight enough to occlude the lumen, but not to injure the internal coats.

The question of using drainage is alluded to below (p. 634). Personally I may say that had I to tie the innominate again I should use kangaroo tendon,* or, failing this, silk. Whichever was used I should endeavour to close the vessel securely, but, considering the probability of degenerative changes in its coats and the volume of blood impinging on the ligature, I should try and use one short of that likely to divide the inner coats. As to drainage, if I succeeded in leaving a dry wound, I should be content to close it after dusting its recesses with sterilised iodoform. If any oozing were going on, I should leave in for forty-eight hours a strip of sterilised iodoform gauze.

The truth is, that these cases of ligature of the innominate in man are too few and far between to give us the only evidence on which we can rely. All experimental work requires most careful weighing and checking before it is acted upon.

At the present time, till we have further evidence bearing on the influence of modern surgery on this operation, we may say that there are cases which are clearly most inappropriate, and that there are certain special precautions which should not be neglected during and after the operation.

First, as to **selection of cases,** the following words of Mr. Holmes † should be remembered. The operation "should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-clavicular joint,* or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is more than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it be tied."†

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* This is preferable to ox-aorta, from the greater facility of obtaining it, the longer lengths in which it is procurable, and its lasting longer.

† *Syst. of Surg.*, vol. iii. p. 112.

The following are amongst the **precautions** indicated:

(1) Rigid antiseptic precautions persevered with till the wound is soundly closed. (2) Use of a reliable ligature in securing the innominate probably diseased—viz., one of sterile kangaroo-tail or silk—with care, if possible, that the knot is not a hard one and does not press strongly on the side towards the artery. (3) Securing the carotid artery at the same time.‡ By this, in Mr. Spencer's words (*loc. supra cit.*), "a thrombus is then formed in the proximal end of the carotid, which extends to the bifurcation, and thus aids a thrombus in forming in the first part of the subclavian as far as the vertebral; otherwise the blood-flow will pass from the subclavian to the carotid close by the distal side of the ligature of the innominate, and so the operation will lack one of the important characteristics of a Hunterian ligation." (4) Obliterating the cavity as thoroughly as possible, after every care has been taken to check all oozing and to leave a dry wound, so as to prevent formation and collection of discharges.

Mr. Thomson, in his exhaustive account of his own case, states his belief that the fatal ulceration into the innominate was brought about by decomposition of discharges collecting at the bottom of the sinus left by the drainage-tube. This decomposition was, he thinks, due to the difficulty of keeping the dressings firmly on a movable part like the neck, to the fact that the skin heals much more quickly than the deeper parts, and that the clavicle assists in preventing the soft parts coming together. He would, in future, use carefully adjusted sponges, and shot-bags over them.

(5) Keeping the patient absolutely at rest till the wound is soundly healed, morphia being used subcutaneously, and any tendency to cough checked at once if possible.

LINE AND GUIDE.—The vessel, one to two inches long, extends along a line drawn from the middle of the junction of the first with the second bones of the sternum to the right sterno-clavicular joint (Holden). Its point of bifurcation varies somewhat.

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* As Mr. Holmes remarks in a footnote, "If the shape of the bones or joints is altered, it is clear that the aneurysm arises in the thorax."

† It is, however, very remarkable that in the cases of Porter and Aston Key, though it was found impracticable and undesirable to ligature the artery owing to its diseased and dilated condition, such changes were set up in the vessel by the exposure and manipulation as to lead to gradual cessation of the pulsation in the aneurysm in one case, and its diminution in the other.

‡ Ligature of the common carotid at the same time as the innominate will not necessarily prevent hæmorrhage, as was shown by Smyth's case, in which the carotid was tied at the same time as the innominate. Hæmorrhage occurred on the fourteenth day, and was repeated at intervals. The vertebral was ligatured on the fifty-fourth day, and recovery ultimately took place. Of five monkeys in which Mr. Spencer tied the innominate, the only one in which the carotid had not been tied died from hæmorrhage. Dr. Burrell, in his case (p. 625) in which the operation was successful, did not tie the carotid.

RELATIONS: IN FRONT.
Sternum ; sterno-hyoid ; sterno-thyroid.
Left innominate and right inferior thyroid vein.
Inferior cervical branch of right vagus.

OUTSIDE.
Right innominate vein.
Right vagus.
Pleura.

INSIDE.
Left carotid.

Innominate artery.

BEHIND.
Trachea.

Collateral Circulation.—This is thus given by Sir W. Mac Cormac (*Ligature of Arteries*, p. 75) :

	CARDIAC SIDE.		DISTAL SIDE.
Trunk.	First aortic intercostal,	with	Superior intercostal of subclavian.
	Upper aortic intercostals,	with	Thoracic branches of axillary and intercostals of internal mammary.
	Phrenic,	with	Musculo-phrenic of internal mammary.
	Deep epigastric,	with	Superior epigastric of internal mammary.

Free communication of vertebrals and internal carotids of opposite sides inside the skull. Communication of branches of opposite external carotids in the middle line of the face and neck.

Operation.—The patient having been brought into as satisfactory a condition as possible by preparatory treatment, the head, body, and arm are placed as in ligature of the subclavian (p. 615). The surgeon, standing in front, makes an incision along the inner third of the clavicle, and another along the anterior border of the sterno-mastoid, meeting the first at an acute angle, each incision being upwards of three inches long. The flap thus marked out is dissected up, the sternal and clavicular heads of the sterno-mastoid divided, and the sterno-hyoids and sterno-thyroids also carefully cut through on a director. This incision was made use of by Mott when he tied the artery in 1818. It appears preferable, as giving much more room in difficult cases, to any other. It has the serious disadvantage of dividing muscles which retract much and leave a large, gaping, deep wound, the difficulty of draining which has already been alluded to. I have mentioned one or two precautions which will, I believe, meet, in part, the above objection to this incision. Where the presence of a large aneurysm with one or more processes to its sac increases enormously the difficulties of this operation, and thus calls for free access to the important parts dealt with, I am of opinion that this division of muscles will be found needful. Mr. Spencer, from his experiments on monkeys, advises the use of a single median, vertical incision, made as if for a low tracheotomy, retracting the sterno-mastoid, sterno-hyoid, and sterno-thyroid, opening the sheath and tying the carotid, and then following this down as a guide to the innominate. He argues ri[illegible] that if the muscles be retracted only, and not divided, when they are released they will come together, so that no cavity will be left in the deeper parts of the wound. Sound as this reasoning is, I fear there is no comparison between ligature of the innominate in monkeys and the same operation under the conditions which usually call for it in man. Every atom of room may be required, not only on account of the importance of the parts dealt with, the great enlargement of the veins, the presence of a dilated subclavian, a process of the aneurysm extending inwards, or a hugely expanded vertebral as in my case (p. 637), but also because the surgeon may feel bound, as I did, to give his patient the benefit of a less risky operation, and thus be driven to divide the sterno-mastoid in order to examine the fitness for ligature of the second part of the subclavian. I would advise division of the muscles (in a case of any real difficulty), but at a point an inch and a half above the clavicle. If they are divided just above this bone the ends retract behind it, and I found the introduction of sutures impossible. My case also taught me that raising the skin and sterno-mastoid together—a precaution I adopted to secure a heavy flap, which will fall better into position, and thus help to close the deep wound—is futile, the contraction of the sterno-mastoid from above raising the skin with it. During these preliminary steps one or two small arteries may be divided and some enlarged veins connected with the inferior thyroids drawn aside or tied with double ligatures; and, in reflecting the above-mentioned flap, the presence of the anterior jugular passing outwards beneath the sterno-mastoid just above the clavicle must be remembered.

The above muscles, when cut, being carefully held out of the way, and a layer of deep cervical fascia varying in strength divided, the pulsation of the carotid is defined, and its sheath opened to the inner side and as low down as possible. Other guides will be found, in the trachea and the subclavian artery, to lead the finger down to the innominate.

The carotid having been traced down, the innominate will be found bifurcating into the carotid and subclavian. It is now that the real difficulties may be met with. (1) Owing to engorgement of the venous circulation, increased by the anæsthetic, the internal jugular and innominate vein may be so much enlarged as to protrude into the wound. (2) An aneurysm may have extended under the artery and flattened it out so as to make it difficult of recognition. (3) The cellular tissue around the vessel and between it and the sternum may be so matted with adhesions as to make it difficult to define the artery and its important relations on the right side—viz., vagus, pleura, and right innominate vein. (4) The artery itself may be enormously diseased and expanded. (5) The bifurcation of the artery may be quite an inch below the joint.

In tracing down the innominate itself, the surgeon must keep his steel director most carefully on the front of the artery. In following the vessel down behind the sternum in order to find a site for his ligature, he will be aided by slightly flexing the head, and by a laryngeal mirror or electric light. The cleaning of the artery must be done with the utmost caution, especially on the outer side, owing to the important structures lying there; of these the innominate vein and the vagus may be drawn outside, but it is only by keeping the director or needle-point very close to the artery here that injury to the pleura can be avoided.

If there be doubt as to the position of the artery, pressure with the finger behind the vessel against the sternum will arrest the pulsation in the carotid and the aneurysm. If the bifurcation of the artery lie, as in my case, a full inch below the joint, attempts should be made, by pulling up the carotid protected by a piece of aseptic gauze, to raise the bifurcation sufficiently for the passing of the ligature. I believe this to be preferable to dragging on the vessel by the ends of a ligature previously tied round the carotid, and left long. If it be impossible thus to raise the bifurcation sufficiently, the inner inch and a half of the clavicle must be removed by disarticulating and sawing through the bone. I would refer my readers to Dr. Burrell's case (p. 625). This surgeon considers this step essential. He quotes Bardenheuer (*Mittheilungen aus dem Kölner Bürger-Hospital*, Estes Heft, 1886) as convinced that ligature of the innominate can only be intelligently carried out by resection of part of the sternum and sterno-clavicular joint.

The needle should be passed from without inwards and a little from below upwards to avoid the pleura. In this case, as in that of the subclavian and other deep-seated arteries, the surgeon will do well to provide himself with needles of different curves (of these the late Mr. Durham's needle, in which the curve is twisted laterally at a right angle to the shaft, is a very helpful one), or with a silver probe sufficiently flexible to take any curve, and with a large eye close to the point (p. 617).

The needle should be loaded with thoroughly aseptic silk, or, if it be preferred to this, after it has passed, a flat ligature of reliable and sterilised kangaroo-tail, should be secured, and then pulled beneath the vessel. It should be tied firmly, as I believe that these ligatures, after soaking, are so supple as not to cut into the vessel (p. 626). Care should be taken to keep the ligature flat around the artery while tying it, and the knot as little projecting (especially towards the vessel) as possible. In addition to the amount of force used, the surgeon will, by watching the aneurysm—all pulsation in which should have ceased—derive some information as to the extent to which he has constricted the vessel. No doubt, severing the vessel between two ligatures would ensure more rest to the parts which have to heal, but the size of the vessel, its probable condition, the doubtfulness as to whether its lumen is completely closed, and the difficulty of placing the ligatures sufficiently far apart forbid the adoption of this step.

The ligature having been tied and cut short, the common carotid should be tied also, about half an inch above its origin. If the thyroidea ima arise from a point at which it is likely to bring in a reflux current which will dangerously disturb the clot, on which so much depends, this vessel should be tied also.*

The wound is now carefully cleaned and dried, the severed muscles carefully united with chromic-gut buried sutures, hæmorrhage most scrupulously stopped, a drainage-tube inserted,† and the wound carefully closed. If the patient will bear it, the limb, previously wrapped in cotton-wool, should be secured to the side and chest, and every attempt made, by elastic bandaging and the aid of a shot-bag, to keep the dressings firmly in place, and thus promote, from the first, steady adjustment of the parts and sound healing. Morphia should be used as freely as is safe, to diminish, as far as possible, the sensibility of the patient to the irksomeness of his position. The slightest tendency to cough should be treated at once. The absolute need of rest and quiet should be enforced upon the patient until the wound is soundly healed.

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* This was the case in Lizars' patient (*Lancet*, 1837, vol. ii. pp. 445, 602; Spencer, *loc. supra cit.*).

† If it be possible to suture the cut muscles satisfactorily, and thus close the deepest part of the wound after this has been carefully dried out, a drainage-tube may be

I am enabled, through the courtesy of Sir W. M. Banks, to give an abstract of a most interesting case of right subclavian aneurysm in which the innominate and, subsequently, the first part of the subclavian were tied. Owing to the exceeding rareness of recovery after ligature of the innominate, and the survival of a patient for thirty-six days after the placing of a ligature round the first part of his subclavian, it is to be hoped that this most instructive case will be published *in extenso*.

J. B., aged 50, was admitted into the Liverpool Royal Infirmary, February 10, 1883, with well-marked symptoms of aneurysm of the third part of the right subclavian. Attempts to treat the patient by rest, &c., having failed, owing to his obstinately persisting in getting up, the innominate and common carotid were tied, February 26, with the strictest antiseptic precautions. The earlier steps presented nothing remarkable. "Unluckily, the bifurcation was quite half an inch lower than it ought normally to be, and this caused some difficulty in getting the aneurysm-needle round the vessel. I used a needle of the ordinary kind, having a large curve, and threaded with silk. There was about a minute of rather anxious work while the needle was being tickled through the tissues surrounding the vessel, a proceeding which was accomplished solely by feeling, as the artery lay too deep for me to see anything that could aid me. By means of the silk thread, a stout kangaroo-tendon ligature was pulled beneath the vessel, then tightened, three knots being placed upon it. I applied the amount of force which I thought would be necessary completely to occlude the artery, but not to damage its coats, and I felt very certain that I had made a thorough and satisfactory ligature of the artery. Whether I really did so or not is a question. . . . . The aneurysm ceased to pulsate. I next proceeded to pass a ligature round the common carotid. . . . . Being engrossed in this, I took no further notice of the aneurysm. But those who were assisting saw that, after an interval of about two minutes, a certain amount of pulsation returned in the aneurysm. I imagined that this must have arisen from the retrograde circulation along the common carotid and subclavian, and so proceeded at once to tighten the ligature (another kangaroo-tendon) round the former vessel. As soon as this was done the pulsation in the aneurysm again became practically imperceptible." A slight return of pulsation was noticed in the evening of the operation.

The restlessness and irritability of the patient during the first few days were frightful. He tossed about the bed, moved his arm as much as the bandages would allow, loudly demanded stimulants, and swore at everybody about him. He was not, however, in the least feverish or delirious. Practically there was never any suppuration, and the extensive wound healed by primary union. All dressings were discontinued on the thirteenth day, and the patient, who had insisted on getting up on the ninth, went out on the twentieth day with the wound sound.

Unhappily, the pulsation, feebly present in the aneurysm on the evening of the operation, became strong and accompanied with thrill by the third day. Pressure with a bag

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dispensed with. If the surgeon, wishing to be on the safe side, especially where the parts have been much disturbed, make use of a tube, it should be removed, if possible, at the first dressing. I followed this course in my case on the day after the operation. When the patient died, on the tenth day, the wound was found at the necropsy perfectly sweet and free from any collection of fluid (p. 638).

of shot was tried, but the patient, by his unruly behaviour, did all he could to prevent any consolidation occurring. When the patient went out the aneurysm was quite as soft, and the pulsation and thrill quite as obvious, as before. It very soon decidedly increased, spreading out under cover of the trapezius and pushing inwards the scalenus anticus. "At the end of five weeks it became clear that either the aneurysm must be left alone and the man abandoned to his fate, or that something more must be done. But what? Galvano-puncture and the introduction of wire or other material into the sac have not proved of sufficient utility to entitle them to be considered satisfactory methods of treatment at the present moment, whatever may become of them in the future. Ligature of the first part of the axillary on the distal side of the tumour is not any better. To lay open the aneurysm and attempt to secure the artery on either side of the aneurysmal opening would almost certainly have been fatal on the spot. To go down through the old cicatrix in search of the innominate, with a view of tying it a second time, seemed very impracticable. Besides, I could not be any more certain of curing the aneurysm the second time than the first. The only thing that remained was to tie the first part of the subclavian. Sixty-seven days after the ligature of the innominate I performed this operation, not using the spray during the dissection, lest it should obscure one's vision, but turning it into the wound after the vessel was tied. By this date the tumour had so increased in size that there was just room on its inner side, and no more, to get at the artery. An incision was made along the hinder margin of the sterno-mastoid, and another extending from it outwards along the clavicle. After getting through the superficial structures, the clavicular portion of the sterno-mastoid was divided, and the internal jugular was followed down to its junction with the subclavian. Here, in consequence of the matting together of parts as a result of the first operation, it became almost impossible to know what one was dealing with, and an unpleasant accident occurred. I tore across a vein of some size close to the point where it entered the angle of junction of the jugular and subclavian. Instantly a rushing and hissing noise showed that some air had got into the venous trunks, and for a brief space the situation was uncomfortable. A finger was put on the aperture, and to our relief the patient showed no signs of being in any way affected by the occurrence. The aneurysm covered by the thin fibres of the scalenus anticus next came into view. My colleague, Mr. Harrison, gently but steadily pushed this outwards with a couple of fingers, and in the very limited space between this and the internal jugular I proceeded to search for the artery, guided by its pulsation. Very slowly, and after an infinity of anxious picking and teasing (for one dared not use a knife), this was exposed about half an inch from the aneurysm. The vessel was obviously thinned and dilated, and this added immensely to the danger of passing the aneurysm-needle beneath it. The needle was threaded with a silk ligature, which drew after it a double catgut ligature. The loop of this being divided, the artery was secured by both portions lying side by side. The knots were drawn very gently, with the intention of merely closing the artery and not of injuring any of its coats. The aneurysm at once became still.

"A very few lines have sufficed to describe this operation, but it took more than an hour to perform, while the difficulty, danger, and anxiety that attended it are almost impossible to describe. Owing to the fact that the parts had already been interfered with, there was a great deal of thickened and cicatricial tissue present. Cutting this was out of the question, as it was impossible to say what was adherent to or mixed up with it. It had, therefore, to be pulled asunder fibre by fibre, with the aid of strong forceps and a dissecting tool. As the operation advanced, the depth at which one had to work became greater and greater, while, in order clearly to make out the various structures, the wound had to be kept absolutely free from blood. Sometimes minutes would be lost in picking up some trifling vessel from which just enough blood would keep welling to obscure the wound. The space in which anything could be done was of the most limited description, and surrounded by dangers on every hand. To the outer side was the bulging aneurysm, to the inner was the internal jugular, below lay the subclavian vein, and immediately beneath the artery itself was the pleura. . . . . Compared with this performance, tying the innominate was a mere surgical amusement, and I should never care to repeat it again."

The patient rallied well from the operation, but a few days later developed an attack of broncho-pneumonia, which exhausted him extremely. He slowly rallied from this, but the wound gaped widely. It ultimately healed, save for a sinus, which admitted a probe deeply. On the twenty-third day the patient got up, and by the thirty-first day had been out in the open air. On the evening of this day hæmorrhage occurred from the sinus; frequent recurrences took place, and the patient died on the thirty-seventh day after the operation. By the fourth day the aneurysm had no trace of pulsation, and was small and hard.*

The following case of ligature of the innominate which was under my care well illustrates some of the difficulties which may be expected:

A. H. was sent to me by Dr. Lockhart Stephens, of Emsworth, February 1890, with a large subclavio-axillary aneurysm. The man gave his age as 48; he looked ten years older, and was stout and flabby, with chronic bronchitis and emphysema. Occupying all the lower part of the posterior triangle, and to be felt in the axilla and between the heads of the sterno-mastoid, was a large aneurysm, six inches by four inches. There was no evidence that the innominate itself was involved. Patient had first noticed the swelling a year before, when it was about the size of a walnut. He had been doing his work as a gamekeeper, and shooting rabbits, till two weeks before his admission, February 10. Chloroform having been given, the parts cleansed, and irrigation with lotio hyd. per. 1-2000 employed throughout, an incision three inches and a half long was made along the anterior margin of the sterno-mastoid, and another transversely outwards, just above the clavicle, over both heads of the sterno-mastoid, to a point over the inner part of the aneurysm. The skin and both heads of the sterno-mastoid were divided together, with the hope of keeping the skin down better when the wound was closed, thus better obliterating the large wound and ensuring earlier healing. The sterno-hyoid and sterno-thyroid being divided, two very large inferior thyroid veins secured, and the internal jugular drawn outwards, the inner part of the carotid sheath was opened and this artery traced down to the innominate. The chief difficulty at this stage was due to what was thought to be a pulsating process of the aneurysm, which extended inwards under the jugular and carotid, but was really a hugely dilated vertebral. The carotid being traced down, it was found impossible to pass a ligature below the bifurcation, which lay a full inch lower than the joint. In spite of the aid given me by the late Mr. Davies-Colley, who drew up the carotid, protecting the vessel with a bit of gauze wrung out of carbolic lotion, I was unable to get my finger or a director sufficiently deep behind the clavicle to make sure of being below the bifurcation. I accordingly removed the inner extremity of the clavicle, disarticulating and sawing through the shaft. I was now able, aided by Mr. Davies-Colley's most efficient help, to bring just the top of the bifurcation into view. More than this was impossible, and the aneurysm-needle (one of corkscrew form lent me by Mr. Durham) was passed by touch round the innominate from without inwards. It was previously loaded with silk, to which a piece of ox-aorta ligature, kindly provided by Mr. Barwell, was knotted. In tying the vessel, I tried to use force sufficient to close it, but not to injure its coats. Judging from the outside, the walls were well puckered together. Pulsation in the aneurysm ceased at once, and never returned. The carotid was then tied, with a similar ligature, about an inch above its origin, not only to prevent any efflux of blood through it, but also because the vessel was probably weakened by much handling. The wound was thoroughly dried out, and dusted with iodoform, a drainage-tube inserted, and the wound united by twelve salmon-gut sutures. By the third day the aneurysm began to shrink markedly, but the following night the patient began to be restless and delirious, and this increased and persisted. The delirium was peculiar. He was incessantly restless, trying to get out of bed, chattering without ceasing, calling to his dogs, &c. It was most difficult to keep his right arm still, and before long it was needful to secure him with straps. Morphia, sulphonal, chloral, chloral amide, hydriodate of hyoscyamin, were all tried, with very little result. There was also evidence of broncho-pneumonia at both bases. The restlessness and chattering delirium continued, and, in spite of the abundance of food taken, the strength became exhausted, and the patient sank on the tenth day. The wound remained quite sweet throughout. At the necropsy the wound was found to be perfectly sweet, without a trace of pus, and levelling up well. A large sacculated aneurysm occupied the second and third parts of the subclavian and the first and second parts of the axillary. In addition to the main sac, which occupied the posterior triangle, a hemispherical dilatation projected into the upper part of the right pleura. Encircling the innominate, just below the bifurcation, which was on a level with the first costo-sternal articulation, was the remains of a ligature, but no knot could be found, and the ligature was movable with the point of a director. Surrounding the bifurcation of the innominate was a small cavity, from which could be squeezed not more than a drachm, if so much, of quite sweet pus-like fluid. The carotid had been tied about a quarter of an inch above the top of the sternum, and here, too, the wall of the vessel was very soft, so that in dissecting it a hole was made in the vessel above the ligature. The knot, however, had held well in position. Running behind the carotid sheath, and given off from the subclavian immediately after its origin, was a long fusiform dilatation, which was probably the vertebral much dilated, as large as the forefinger. A small window being cut in the aneurysm showed that this was filled with a greenish-tinted, jelly-like coagulum, not blood-stained, and traversed in every direction by isinglass-like threads. The only remnant of a cavity was quite at the back part, where a space into which the tip of the finger could be introduced contained a little fluid blood. The inner aspect of the sawn clavicle was smooth, with granulations save just at its upper part. The pleuræ were absolutely healthy. Both bases were the seat of broncho-pneumonia. It is quite possible that this was septic, as no bacteriological examination was made of the very small amount of fluid in the wound. It should be noted that the man had chronic bronchitis before the operation. The mediastinal connective tissue was extensively occupied with air: this had not penetrated beneath the pulmonary pleura, nor produced interstitial emphysema. The aortic and mitral valves, the latter especially, were diseased; the aortic arch was the seat of atheroma, dilated uniformly, irregular on the surface and rough internally, but not calcareous. The abdominal aorta was very bad, full of calcareous plates. The kidneys showed early interstitial nephritis. There was a small hard mass of clot in the innominate, below the ligature; little in the carotid. The brain was normal.

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* The notes of this case contain no mention of a necropsy.

Causes of Death after the Operation.—It may be expected that most of these will, with antiseptic precautions, disappear, viz.:

1. Suppurative cellulitis and mediastinitis.
2. Lung trouble—*e.g.*, bronchitis, pleuro-pneumonia.
3. Pericarditis.

There still remains the terrible complication of secondary hæmorrhage, which has occurred, as yet, in almost every instance, and has always proved fatal, save in Dr. Smyth's case.

Secondary hæmorrhage may occur up to the sixtieth day, as in Graefe's case. It has already been discussed how far modern surgery is likely to prevent this, and certain precautions have been enumerated at p. 631. The treatment, as shown, is mainly preventive. When once bleeding has occurred, little can be done beyond tying the vertebral and common carotid, if this has not already been performed, plugging the wound with iodoform gauze wrung out of carbolic acid lotion (1 in 20) or turpentine (p. 578), and putting on pressure with shot-bags.

SURGICAL INTERFERENCE IN ANEURYSMS OF THE INNOMINATE AND AORTA.

While the distressing nature of these cases justifies a resort to surgery when medicine fails, I would point out—(1) That the surgeon is often called in too late, in large thoracic aneurysms, where treatment of any kind is certain to be unsatisfactory. (2) The fact has been too much lost sight of, that large thoracic aneurysms, with their size, varying degree of sacculation, restricted power of collapse, and important surroundings, are on quite a different footing, for operative interference, from aneurysms of the extremities. Further, the disease here is much less often a local one. (3) That, with regard to the amount of relief which surgery can fairly be expected to give, when the large number of cases, published and unpublished, which have been treated surgically in the last few years are duly weighed, it is clear that permanent cures are extremely few; and that while in some cases decided relief is given, in many published at the time as successes, were the sequel followed up, it would be found that very little real relief had followed, while in not a few, what with the risk of the anæsthetic, the excited circulation, the partial cure of the aneurysm in one direction, and the tendency set up to spread at another spot, possibly less able to bear the strain, and perhaps with more important surroundings, surgery has not only failed to check but has actually hastened the progress of the aneurysm.

The advisability of resorting to surgical means will be considered under the heads of—A, Diagnosis; B, Treatment, the latter including —(i.) Ligature, (ii.) Introduction of Foreign Bodies, (iii.) Galvanopuncture.

A. **Diagnosis between Innominate and Aortic Aneurysms.**—It is well known how extremely difficult this matter is; the expression of a confident opinion is, too often, quite out of the question (p. 641). While a precise diagnosis is usually impossible, no pains should be spared in going into all those points which may help in deciding how far the aneurysm is probably limited to the innominate or to the aorta, and, in the case of this vessel, which part of the arch is chiefly encroached upon; for it is only by paying attention to the above points that answers can be given to the two questions which arise—viz., (1) Is any operation justifiable at all? (2) If an operation is justifiable, what is it to be?

Chief Points to pay Attention to in Diagnosis.

1. *The Position of the Aneurysm.*—This is obviously only of value in a few cases, when the patient is seen early, or when he can be relied upon for an intelligent history of his case. Mr. Wardrop's rule was, that innominate aneurysm first presents itself to the inner side of the right sterno-mastoid, carotid aneurysm in the interval between the two heads, and a subclavian one to the outer side of the muscle. Mr. Barwell* writes of the first of the above thus:—"The tumour of an innominate aneurysm generally occupies the episternal notch, but chiefly on the right side, and, even though it may not rise high, takes up the whole breadth of this space. On gently pressing the finger backward and downward, the rounded margin of the sac can be felt. After a little time the sternal end of the clavicle protrudes abnormally, and partakes in the pulsation (communicated), while the sternal and, afterwards, the clavicular portions of the sterno-mastoid are also pushed forward. Not unfrequently the first costal cartilage, outside where it joins the

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* *Intern. Encyl. Surg.*, vol. iii. p. 507.

sternum, is also abnormally prominent, and throbs with the beat of the tumour."

Mr. Heath thus describes (*Dict. of Surg.*, vol. i. p. 81) the possible points of appearance of an aortic aneurysm: "If on the ascending portion of the arch, the sac presses against the sternum, producing gradual absorption of the wall of the chest, and communicating a marked impulse to the right side of the sternum as high as the sterno-clavicular joint, which may be invaded by the tumour in the later stages. If on the transverse portion of the arch, the sac encounters but little resistance in an upward direction, and hence is apt to invade the interclavicular notch, to compress the trachea and occasionally the œsophagus, and to produce marked spasm of the larynx by interference with the left recurrent laryngeal. When a sac of this kind rises into the neck, it is a matter of uncertainty to which side it should be allotted, since a tumour projecting most to the right by no means necessarily *originates* on the right side, and *vice versâ*."

2. *The Pulse.*—If a decided diminution be found in the right radial and carotid, the aneurysm is probably of the innominate; but an aortic aneurysm near the root of the innominate will bring about the same result.

3. *Pressure Symptoms.*—These will vary with the position as well as the size of each form of aneurysm. Thus, in innominate aneurysm pressure symptoms will vary according as the sac is high up or low down, and pressing inwards or outwards. As to œdema, the value of this must remain undecided while surgeons hold such opposite views.

' Thus Mr. Heath* and Sir J. E. Erichsen† speak of œdema of the right side of the neck and upper limb as first noticed. Mr. Barwell,‡ on the other hand, speaking more particularly of the low form of innominate aneurysm (usually combined with aortic disease), writes: "The point to be especially remarked is this—the pulsation, dulness, abnormally loud heart sound, &c., are on and to the *right* of the middle line; the venous congestions are on the *left* side of the body, nor does the right participate till late in the disease. . . . . When the right side is also involved, the aneurysm will have become large."

I cannot find that the other pressure symptoms—viz., laryngeal or tracheal dyspnœa, and irregularity of the pupil—are really distinctive between innominate and aortic aneurysm.

Mr. Barwell considers that the following combinations of symptoms "furnish remarkably positive evidence" in aortic aneurysm: "For instance, pressure wholly and entirely on the right bronchus; congestion of both arms and both sides of the head and chest; tumour symptoms, chiefly about the second space and rib, considerably to the right of the sternum; heart displacement, if any, directly outward; the pulses equal . . . . indicate disease of ascending aorta. Congestion of the left arm, supra-clavicular region, and side of the head; aneurysmal character of right pulse (radial and carotid); tumour symptoms a little to the right of the sternum, and probably some tracheal dyspnœa, are symptomatic of aorta-innominate aneurysm. Modification of left radial pulse, affection of left vocal cord, left venous congestion, tracheal dyspnœa, and obstruction of air to both lungs, with tumour symptoms on and to the left of the median line, mark disease of the transverse aorta. Obstruction to the entrance of air to the left lung alone, with pains at the back and along the intercostals, is indicative of disease of the third part of the arch."

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* *Loc. supra cit.* † *Surgery*, vol. ii. p. 75. ‡ *Loc. supra cit.*

4. *Displacement of the Heart Downwards.*—The more marked this is, the greater is the probability that the aneurysm is aortic.

Difficulties and Fallacies in the Diagnosis.

1. The proximity of the heart. "When there is a bruit, it is extremely difficult to distinguish whether it is limited to the tumour, or is propagated into it from the cardiac valves; whether the pulsation is limited to the neck, or extends also into the thorax; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated."

2. "The growth of aneurysms in the cellular tissue of the mediastinum and root of the neck is so free that instances have been observed of aneurysms of the arch of the aorta causing compression of the subclavian and carotid, without any disease of those vessels; while, on the other hand, if the aneurysm approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased" (Holmes).*

3. The distribution of the branches of the aorta may be anomalous.†

The following remarks of Mr. H. Morris on a case of aortic aneurysm illustrate the extreme difficulty of diagnosis here:

> No one who examined this woman questioned that the aneurysm was innominate, and some very capable diagnosticians considered it to be a simple sacculated aneurysm of that vessel. Even after dissection, it was impossible to make out its true character until the sac had been laid freely open in front, and the innominate artery behind. The situation and outline of the tumour, the pain in the shoulder and over the right side of the head and neck, led to the diagnosis of innominate aneurysm. The origin of the disease from the aorta might have been suspected if more weight had been given to the severe *gnawing* pain across the front of the *chest* suffered at the onset; to the dilated veins on the right side of the upper part of the chest; to the equality of the radial pulses; to the absence of any cough, dyspnœa, and throat-dryness, of any deflection of the trachea, of any numbness or loss of power in the right arm (such frequent symptoms in innominate aneurysm); and to the fact that aortic aneurysm causes tumours in the neck.

B. Treatment.

I. LIGATURE.‡

Aids in selecting Cases fitted for Operation.—Mr. Barwell (*loc. supra cit.*, p. 520), writing on innominate aneurysms, has formulated the following aphorisms:

i. An aneurysm commencing suddenly, especially if traceable to some over-exertion, is more likely to be benefited by operation than one arising gradually and without mechanical cause. ii. Distinct sacculation is a most desirable condition; fusiform dilatation of the innominate indicates almost certainly a similar condition of the aorta and widespread arterial disease. iii. If symptoms show the aortic arch to be also affected, the disease should be limited—that is, should not extend along the transverse portion. It should be of the sacculated variety, not a general dilatation of the whole calibre. Absence of any other aneurysm, especially of the rest of the aorta, must be ascertained. iv. Absence of rasp-sound along the aorta, or any other indication of extensive atheroma, should be verified. v. Aortic incompetence, unless very slight, is a decided objection, as is also mitral disease, or considerable hypertrophy of the heart. vi. The patency of the vessels leading to the brain should be investigated by making a few seconds' pressure on the carotids alternately and then simultaneously. vii. Absence of visceral disease must be ascertained.

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* *Syst. of Surg.*, vol. iii. p. 14.

† Mr. Holmes quotes the following instructive case: In a patient in whom, from other symptoms, there was no difficulty in diagnosing an aneurysm of the arch of the aorta, one circumstance was difficult to account for—viz., that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death the right subclavian was found to be the last branch of the aorta. Passing between the aneurysm and the spine it had been compressed, while the carotid was unaffected.

‡ Many of the remarks below apply also to the two other methods of surgical interference—introduction of foreign bodies into the sac, and galvano-puncture.

Before deciding to recommend operative interference in these aneurysms, the surgeon should, I think, consider most carefully the following points, which appear to me to be the outcome of recorded cases:

1. It is possible that too much importance has been attached to a very few successful cases, and that too little attention has been given to the fact that numerous unsuccessful cases have occurred which have never been published.

2. It is certain that, in some cases, operative treatment may not only fail to check the progress of the aneurysm, but may actually and decidedly hasten the fatal issue. This grievous result may not only be brought about by the difficulties of the operation itself, but also by this special and untoward result which is common to all operative treatment here—viz., that, as in these aneurysms the contiguous part of the large vessels (aorta especially) is often extensively diseased, and as other aneurysms may be present, ligature of one vessel, by checking the flow of blood at one part, may throw the current suddenly upon another, perhaps unfit to bear the strain, or, from its relations, more likely to produce grave pressure-symptoms.* Sufficient attention has not been paid to this most important point.

"If the enormous difficulty of diagnosis, the great risks of the operation, the possibility of spontaneous improvement, if not of cure, and of palliation by rest and diet, and also the fatal results of recorded operations, be taken into due consideration, it seems that the distal ligature on the right side should be limited to desperate cases, and then performed only with the expectation of relief, not of cure" (Morris). †

Contraindications to Operative Interference.—Mr. Barwell (*loc. supra cit.*, p. 528) lays down the following: (1) When tumour symptoms reach widely on both sides of the middle line; (2) when, with paralysis of the left vocal cord, there is obstruction of the right bronchus; (3) when there is evidence of considerable aortic incompetence; (4) when there is mitral disease or considerable cardiac hypertrophy; (5) when there is, in the course of the aorta, the rasping sound of calcification or advanced atheroma, more particularly if the superficial vessels are rough and rigid; (6) when there is pain about the spine and intercostal nerves; (7) when there is obstruction of the left bronchus only; (8) when there is pressure on the left apex, and expectoration of frothy blood.

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* The rapid extension of the aneurysm in another direction after its original growth has been checked by operative interference is well shown by a case of Dr. Churton's (*Clin. Soc. Trans.*, vol. xix. p. 261), in which, subsequently to galvano-puncture, the blood-pressure found out other weak spots in addition to the original aneurysm, thus bringing about other saccular projections and fatal rupture into a bronchus.

† *Loc. supra cit.*, p. 103.

Choice of Vessel.—Question of Simultaneous or Consecutive Ligature.—I have no space here for quoting statistics, which are, after all, of inferior value to the authoritative opinions of those who have worked most at this subject. The earliest and foremost of these is Mr. Holmes; as it is to his opinion that English surgeons will naturally turn, the most important of his views are given here.

1. "One thing, I think, has been fully proved—viz., that the distinction which was so much insisted on between aortic and innominate aneurysm is of less importance in regard to the distal operation than used to be taught, and that a case of innominate aneurysm which otherwise seems appropriate for operation, need not be rejected because it is suspected or known that the aorta is also involved. It has also been satisfactorily proved that aneurysms purely aortic have been much benefited by distal operations. It remains to inquire what cases should be selected, and what arteries should be tied in each case."

2. "To my mind the clearest evidence of benefit has been in the case of ligature of the left carotid in the treatment of aneurysm affecting the transverse part of the arch." In a case of this kind it was the evident extension of the tumour up the neck and towards the trachea which made Mr. Holmes think that the ligature would prove beneficial; and the result even surpassed his expectations, the patient being alive and in tolerable health five, and probably seven, years after the operation. Thus Mr. Holmes, considering that the applicability of the distal ligature depends largely on the observed growth of the tumour, would think ligature of the subclavian justifiable if, in innominate or mixed aneurysm, the tumour was making rapid advance under the sternomastoid. He also draws attention to the importance of estimating pressure signs as indicating extension of the aneurysm, evidenced by the condition of the veins, the breathing, the pupil, &c. (p. 640).

3. With regard to operations on the right side in cases of innominate or mixed innominate and aortic aneurysm, opinions vary as to whether the carotid or subclavian should be tied simultaneously, or whether the carotid should be tied first. Mr. Holmes, who holds this latter view, evidently thinks that ligature of this vessel may be sufficient without any consecutive ligature of the subclavian, unless indications arise—*e.g.*, the manifest growth of the subclavian portion of the sac, or the effect of compression of the subclavian in diminishing the size or the pulsation of the tumour.

Mr. Holmes' chief reasons for preferring ligature of the carotid alone as a first step are—(*a*) that while the number of cases of simultaneous ligature is much the larger, the most striking instances of success have followed ligature of the right carotid alone; (*b*) in some cases, where ligature of the subclavian has been also resorted to later, the aneurysm was already diminishing and becoming firmer after ligature of the carotid; (*c*) the simultaneous ligature of two such vessels as the carotid and the subclavian may be a very formidable undertaking from the prolonged dissection and difficulties with the anæsthetic; (*d*) as ligature of the left carotid has proved sufficient in aortic aneurysm, a similar step should be tried on the right side in innominate aneurysm.*

Another interesting and unsettled question bearing on this matter of ligature of large vessels near the heart is **the most appropriate material for ligature.** This has been already discussed (p. 626).

Facts which show that the resort to Ligature has been justifiable. (1) Solidification and diminution in the size of the swelling. (2) Diminution of pulsation. In one case of Mr. Barwell's (*Med.-Chir. Trans.*, vol. lxviii. p. 130), a month after simultaneous ligature of both arteries for innominate aneurysm, the swelling again began to increase, and the solidifying tumour to soften, pulsation also recurring; this went on for about two weeks, when the swelling again solidified and decreased, recovery ultimately taking place. (3) Improvement in dyspnœa, dysphonia, and dysphagia. (4) Regain of power over a limb. (5) Expectoration of muco-purulent discharge, which has been accumulating in the lungs owing to interference with expiration from pressure on the trachea.

Very little has been done in the last few years† to settle the value of the treatment of thoracic aneurysm by ligature of the large vessels in the root of the neck. Mr. C. Heath (*Brit. Med. Journ.*, Feb. 19, 1898) gives his personal experience of the distal ligature. Where the disease involves the transverse part of the arch, he would be inclined to follow Dr. Cockle's suggestion as regards tying the left common carotid; where the disease involves the ascending part of the arch, Mr. Heath would tie both the right carotid and the subclavian, so as to diminish, as far as possible, the current through the innominate. Owing to the frequent additional embarrassment of breathing brought on by an anæsthetic, Mr. Heath would strongly advise the employment of cocaine in all future operations on the large vessels of the neck. Mr. Heath's final summing-up of the results of distal ligature in cases of thoracic aneurysm will meet with the assent of all thoughtful surgeons who are acquainted with the pathology and morbid anatomy of this disease, and with all that surgery has effected: "The results, taken as a whole, are, perhaps, not very encouraging; but it must be borne in mind that, in dealing with a practically incurable disease, a prolongation of life, for even a few months, may be worth attempting."

II. INTRODUCTION OF FOREIGN BODIES INTO THE SAC.—A. WIRE, HORSEHAIR, &C.—This method was originally brought before the profession by Mr. Moore (*Med.-Chir. Trans.*, vol. xlvii. p. 129), who introduced twenty-six yards of fine iron wire into an aortic aneurysm.

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* Mr. Barwell (*loc. supra cit.*, p. 328) goes a good deal further as to the points which he believes will serve to guide the choice of the surgeon. Time alone will show how far these are reliable.

† Messrs. Rose and Carless record (*Brit. Med. Journ.*, Dec. 3, 1898) a case of aneurysm of the arch of the aorta, involving the root of the left carotid, treated by distal ligature, first of the left carotid and then the subclavian. Distinct benefit followed, and lasted up to four months after the operation, the date to which the report is continued.

No relief followed, inflammation of the sac set in, and the patient died five days later.

More recently Dr. Cayley has published a similar case, in which forty feet of wire were introduced by Mr. Hulke. Some relief was given to the pain, and some consolidation had evidently taken place; but extension followed in another direction, causing urgent tracheal dyspnœa. On this account wire was introduced a second time, thirty-four feet being got in. Death followed nine days later. Owing to this material being considered too irritating, it has not been much used.

Other surgeons have made use of catgut and horsehair, but with these less irritating substances the great difficulty is to get much into the sac, as they readily bend on themselves in the cannula.[*] In the summer of 1887, in a patient of Dr. Pye-Smith's, with a large aortic aneurysm coming through the chest wall, I introduced about forty feet of horsehair by means of an ingenious method suggested to me by Dr. Perry. No good was done, the patient dying shortly after, worn out with pain. The necropsy showed that the clot formed by the horsehair was too localised to have effected much in the huge cavity formed by the aneurysm.

B. NEEDLES.—While, for reasons already given, none of the surgical methods employed in thoracic aneurysm can be considered satisfactory, this one, owing to the scientific basis on which Prof. Macewen has placed it, and its results in his hands, is more deserving of trial.

Suggested by Mr. Moore, it has been tried by Prof. Macewen, Mr. Heath, and Mr. Puzey.[†] Mr. Heath made use of it in a traumatic aneurysm of the subclavian where amputation at the shoulder-joint had failed. Three pairs of sewing-needles were introduced into the tumour, each pair being made to cross in the sac; they were not withdrawn until the fifth day, by which time considerable clotting had taken place. The aneurysm gradually became solid; but bronchitis supervened, and the patient sank seventeen days later. Mr. Puzey followed Mr. Heath's plan in an aneurysm of the innominate, but, no apparent effect taking place at the end of four or five days, other needles were inserted as the first were withdrawn, but at different parts of the swelling. This procedure being carried out for several weeks, the aneurysm finally almost disappeared behind the sternal end of the clavicle. Unfortunately, the needles set up some chronic cellulitis, septicæmia followed with vomiting, and fatal rupture of the sac. Mr. Puzey thinks this case affords a warning against pushing this treatment too far, and that it would be better to wait patiently the results of the first introduction of the needles before proceeding to insert others.

Prof. Macewen, who used this method first as long ago as 1875, has published (*Lancet*, 1890, vol. ii. p. 1086) a most interesting paper on the use of pins to secure the formation of thrombi, and so the cure of aneurysm.

"The instrument employed is a pin of sufficient length to completely transfix the aneurysm, and to permit of manipulation within it. Its calibre ought to be as fine as possible, the strength being only sufficient to penetrate the coats of the aneurysm and the intervening tissues. This cylindrical pin tapers to a point, like an ordinary sewing-needle, and has on its opposite extremity a somewhat rounded head. As the coats of aneurysmal sacs vary in thickness, these pins must be made of various calibres. They ought to be finely polished, not only to facilitate their introduction, but to help to render them aseptic. Before performing the operation, the skin over the aneurysm ought to be carefully cleansed and rendered aseptic. The aseptic pin ought then to penetrate the sac and pass through its cavity until its comes in contact with the opposite side. It ought to touch this and no more. Then one of two methods may be employed: either to move the pin over the surface of the inner wall so as to irritate its surface, or to allow the influence of the blood-current playing on the very thin pin to effect the same object. If the walls penetrated by the pin be dense, the former method will be preferable, as the force of the blood-current produces such a feeble action on the thin pin as to be insufficient to move it to and fro while it is firmly grasped by the dense wall. After acting thus for ten minutes at one part, the point of the pin, without being removed from the sac, ought to be shifted to another spot, and so on until the greater portion of the internal surface opposite to the point of entrance has been touched: this ought to be done in a methodical manner. A single insertion of the pin through the sac into its interior may be sufficient to enable the point of the instrument to come in contact with the greater part of its internal surface; but, in some cases, puncture from various sides of the external wall may be necessary, so as to reach portions of the tumour which cannot be attacked from the first puncture. While the pin is in the aneurysm, it is surrounded by a portion of aseptic gauze, or moistened with an antiseptic lotion. When it is withdrawn from the aneurysm, the part ought to be covered with moist antiseptic dressing, which ought to be maintained for several days. The period a pin may remain in an aneurysmal sac without doing damage is perhaps dependent on the individual, and the state of the aneurysm, but it ought never to exceed forty-eight hours. It is questionable whether all the necessary advantages derivable from the irritation of the wall of the aneurysm could not be produced within a few hours. . . . . If the aneurysm be very large, several pins may be introduced from several points, always allowing a considerable interval to exist between each, otherwise there might be too much damage to the vessel wall at one spot. . . . . When the pin has been withdrawn, though there may be a little thickening of the tissues in the neighbourhood, there will probably be little or no diminution of the excentric impulse. Occasionally it may be weeks before any distinct or tangible thickening of the coats can be made out. In other instances this may be discernible at a much earlier period. But, as a rule, a distinct thickening of the coat is tangible at an early period."

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[*] I know of one case in which specially-prepared very long pieces of catgut were introduced into an aneurysm in the neck. At the necropsy some of these were found to have passed on, beyond the aneurysm, into the splenic artery. In the *Ann. of Surg.*, vol. iv. No. 2, a case of Dr. Ransohoff, of Cincinnati, is recorded, in which ninety-six inches of flexible silver wire were passed into an aneurysm of the aortic arch. After the first forty-eight inches had been introduced, syncope, with impending death, set in. With the aid of stimulants the operation was completed. For a fortnight the symptoms were improved, when œdema of face and right arm appeared; ninety-eight inches of wire were then passed into another part of the sac. The patient died eight days later, from rupture of the aneurysm. The syncope was found to have been caused by a loop of wire which had passed beyond the neck of the sac into the aorta, where it was probably deflected by the aortic valves.

[†] Art. "Acupuncture," *Dict. of Surg.*, vol. i. p. 25.

It will be seen that the aim in Prof. Macewen's use of acupuncture differs somewhat from that of other surgeons, in that his object is to irritate the wall of the aneurysm, the irritation being carried just so far as to set up reparative exudation in the parietes, infiltration of these with leucocytes, and then a further separation of these from the blood-current. This irritation is set up at as many points as possible, so as to produce numerous white thrombi, and so complete occlusion as soon as possible. Of the four cases given by Prof. Macewen, three are of especial interest in their bearing on the treatment of aneurysm now under discussion.

No. 1 was a case of aortic aneurysm seen at an advanced period when threatened by impending death from dyspnœa. It was treated by the introduction of pins, the first early in December 1887, this being repeated on seven occasions, with a few days' interval between each. On December 20, dyspnœa reappeared, and, returning on December 31, proved fatal. At the autopsy two-thirds of the aneurysm was filled with a white, firm, laminated thrombus; had the deposition continued at the same rate, it is clear that complete occlusion would have occurred in a few weeks.

Another case was an aneurysm of the abdominal aorta, treated by the same formation of white thrombi; the cure was interrupted by the patient feeling so well that he determined to return to work (engine-driving) after a month's treatment, though the aneurysm was not consolidated. This patient was still alive and in seeming good health when last heard of, two and a half years subsequently.

The third case, which is given in great detail, is the most interesting of all. The aneurysm was here in the thoracic area, probably of the left subclavian, and accompanied by great swelling, pain, numbness, and loss of power in the left arm. Pins were introduced on February 27, March 3, 17, and 24, a gradual thickening of the walls ensuing, as made evident by the greater difficulty experienced in penetrating the coats of the aneurysm, a pin of very fine calibre being used at the onset, some much stouter and more rigid being required later on. During the next four months there was much diminution in the swelling and pain. Pins were again used on five subsequent occasions, but as in two of them it was doubtful if any cavity was entered, their use was discontinued. During the following months there was slow but continuous decrease in the swelling, and the œdema and pain gradually disappeared entirely, the patient being finally able to resume all her ordinary duties.*

It would appear from the above report that an anæsthetic was not needed in any of the above cases—a point of great importance in thoracic aneurysm where dyspnœa and atheroma may be present.

Prof. Macewen has kindly sent me, July 1895, the following abstract of his most recent experience:

"I have had three cases of aneurysm treated since I wrote my paper. One at root of neck, subclavian, but involving aorta; cure absolute. One aortic, transverse arch; greatly thickened and improved; patient can go freely about and follow his usual avocation, from which he was debarred prior to operation. One a very large popliteal, in which consolidation took place rapidly, but owing to the great pressure exercised by the aneurysm on the surrounding parts, which was apparently increased by the consolidation, incision had to be made into the sac. Firm, laminated white thrombi were found inside the sac, part of which was turned out to relieve the pressure and to preserve the vitality of the limb. The patient made a rapid recovery, and is now quite well, the remainder of the white thrombus becoming converted into dense fibrous tissue, which subsequently has undergone great shrinking.

"Quite a number of very advanced aortic and abdominal aneurysms have been seen by me—so advanced as to preclude interference. In several an exploratory puncture was made for diagnostic purposes, when the eroded bodies of the vertebræ were felt bare inside the aneurysmal sac. These were not treated.

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* Another very successful case, under the care of Caselli, of innominate aneurysm treated by Macewen's method, will be found briefly given in the *Revue de Chir.*, 1892, p. 892, and two unsuccessful cases, *Glasgow Med. Journ.*, 1891, pp. 280, 453. Prof. Macewen pointed out (*ibid.*, p. 454) that this method required cases to be carefully selected, and that it was not to be used in those which could not get well otherwise.

"I have heard of cases which were so advanced that 'they burst before the pins which had been sent for to treat them with had arrived.'"

III. Galvano-puncture.—This method has for its object the production of clotting without the risks and difficulties connected with the introduction of foreign bodies—*e.g.*, wire. Like the other methods, it has scarcely had a fair trial, being too often not made use of till the size attained by the aneurysm forbids any hope of cure, and almost of relief. It is inferior to Prof. Macewen's use of needles, in the possible production of eschars and in its much less simplicity.

Points to pay Attention to.—(1) To avoid production of heat, pain, and sloughing of the skin, the current* used should be a comparatively weak one. As an anæsthetic is not usually required, the time occupied may be considerable. (2) The needles should be of steel, as fine as is consistent with perforating the tissues, in order to diminish pain, hæmorrhage, and risk of sloughing. (3) To avoid the same risks, the needles should be insulated within about half an inch of their points by two layers of spirit varnish. (4) As it has been proved that the effect of electrolysis on blood at the positive pole is a fairly firm and tenacious dark clot, while the negative rather produces a pinkish, frothy substance, it seems wiser to connect the needle or needles introduced into the sac with the positive pole, while a large sponge, wrung out of warm salt-water, is connected with the negative pole and applied to the chest wall near the swelling. (5) A sitting should not be prolonged over thirty or forty minutes. The punctures had best be closed by collodion. (6) The operation should not be repeated too soon: time should be allowed for all local reaction to cease, and for consolidation of the coagulum to occur, which often takes some time.

Drawbacks and Dangers.—(1) As pointed out by Mr. Holmes, it is a radical defect of this method that it acts by inducing "passive" coagulation of blood in the sac. Hence, it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In fact, the cases are few in which a perfectly happy result has been obtained, but some of these are worthy of particular attention.

Amongst these is a case of Ciniselli's (Holmes, *loc. supra cit.*), in which an aneurysm of the ascending aorta, quickly increasing, pushing out the third and fourth ribs, with powerful pulsation, rapidly diminished with much solidification after galvano-puncture for forty minutes, the patient resuming his work as a coachman ten weeks later. In Dr. McCall Anderson's case the aneurysm was a small one, about three and a half inches in diameter; after galvano-puncture on three occasions the swelling was only about one-quarter of its previous size, and for the most part very solid. In a case of Dr. Carter's (*Lancet*, 1878, vol. ii. p. 761), an aneurysm of the thoracic aorta appearing in the right sub-clavicular region, and accompanied by much pain, was treated by galvano-puncture on three occasions with very great relief, the pulsation becoming almost imperceptible and the pain disappearing.

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* Dr. McCall Anderson, in a most successful case (*Lancet*, 1873, vol. i. p. 261), employed four to six cells of a Stöhrer's battery. In a case of Dr. Ord's (*Lancet*, 1880, vol. ii. p. 450), followed by temporary benefit, six to eighteen cells of a Foveaux's battery were used. Dr. Bastian (*Brit. Med. Journ.*, 1873, vol. ii. p. 595) made use of five to ele [illegible] the same battery.

Dr. Stewart, of Philadelphia (*Amer. Journ. Med. Soc.*, vol. ii. 1892, p. 426), advises the use of electrolysis in combination with the introduction of wire. He claims that with the combined method a smaller and safer amount of wire can be used, and that, "instead of a soft, unstable coagulum about the wire, tardy in appearing, there may be produced almost immediately a tough clot, which, in favourable cases, should tend by accretion to produce prompt obliteration of the sac cavity." Out of eight cases collected two were successful.

In deciding between the introduction of foreign bodies (*e.g.*, wire) and the use of the galvano-puncture, I think that Macewen's needles (p. 645) deserve a further trial.

It is clear, however, that, if anything like prolonged relief is to be given, any operation must be resorted to at an earlier date than has hitherto been the case. Where rapid increase and thinning of the coverings of a large sac are present, together with a wide communicating opening, and where diffuse aneurysmal changes outweigh the amount of sacculation present, the surgeon who declines to interfere will do wisely. And I would again draw attention to the remarks at p. 642 (a point to which attention has not been sufficiently directed), that surgical interference may, in cases of large aneurysms, do more harm than good by diverting the blood-current from the original aneurysm into some outlying and unsuspected secondary sac, and thus cause dangerous and, it may be, fatal pressure on important parts which have hitherto escaped. Besides this danger, three others have to be remembered when wire is introduced. (1) Embolism. (2) Suppuration of the sac. Both these have been made much rarer by carefully rendering the wire aseptic. Any inflammation of the sac should at once be treated by ice-bags. (3) Introduction of the wire, &c., beyond the aneurysm (footnote, p. 645).

PART III.

OPERATIONS ON THE THORAX.

CHAPTER I.

REMOVAL OF THE BREAST (Figs. 223 to 232).

Indications.—The following remarks must be considered to refer to that most common and important of diseases—carcinoma.

Removal of the breast is an operation which deserves most careful attention, on the following grounds—viz., the frequency and the distressing nature of the results of cancer here, and the fact that, while the operation is still a stigma on our profession, there is reason to hope that it is, yearly, becoming more successful. The first two of the above points need only to be stated. When I speak of the operation of removal of the breast for carcinoma being still a stigma upon our profession on account of the bad results, I do so advisedly. I am aware that in many ways we are not to blame. Women will always be unwilling to make known their fears here, on account of a natural delicacy; but another reason leads them to conceal the earlier stages of a growth (in which alone it can be thoroughly dealt with), and that is the well-known want of success which, hitherto, has accompanied operation. Surgeons are also not to blame for the fact that precious time is often lost by the medical attendant when he is consulted, in some cases from a mistaken kindness and desire to make light of fears, in others from a disbelief in the value of operation here.

Here, as in all cases of malignant disease, early and thorough operation* is needed. With regard to the latter, the limits of wide and thorough operating have probably been reached, but can it be said that these cases are submitted to operation as early as might be the case? Is it not rather the truth that in the majority of cases the operating surgeon does not get his chance until the disease has had time to pass beyond its first stage, and to spread to parts outside the breast itself, as evidenced by the adhesion to the skin and by the glands found affected when the axilla is opened? While in malignant disease of the sexual organs we shall always have to deal with a larger proportion of late cases than elsewhere, there is no doubt that we should diminish the number of these late cases if both the patients and the general practitioners who are first consulted realised more clearly, and if the latter impressed more strongly on their patients—(1) that there are, every year, an increasing number of patients who are living in good health several years after the operation; (2) that the operation, while serious, is not a dangerous one; (3) that if the disease does recur after the improved operation of the present day the recurrence will be delayed; (4) that the operation of the present day promises much better results, but that these results will only be secured by the operation being an early one—*i.e.*, while the disease is in its first stage, and limited to the bosom; (5) that in this first stage, in which operation is so essential, there is an entire absence of pain, or of much or anything to see: thus, a lump must not be neglected because it is painless, as is so often the case; (6) that, when in doubt as to whether a persisting lump which he is examining is carcinoma in its first and quiescent stage, or induration, or a deeply-lying cyst with thick walls, the general practitioner should consider it his duty to have the lump excised at once (*vide infra*), and the breast dealt with as may prove necessary.

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* While on the subject of operating thoroughly and on wide lines, I would quote some words of Mr. Bennett May in his Ingleby Lectures (*Brit. Med. Journ.*, May 29, 1897, vol. i. p. 1338)—words weighty from their outspoken truthfulness: "The operation in too many cases is not practised to the best advantage, and is not used for all it is worth. Certainly some of the disrepute and prejudice which have surrounded it may fairly be ascribed to the incomplete and inadequate manner in which it is too often done by men who have had no proper surgical training, and whose ill results serve to injure the cause as a whole, and to reflect prejudicially on the work of others. The fact is, it has been everyone's operation because it has been thought to be easy."

Results and Dangers of the Improved Operation for Removal of Malignant Disease of the Breast.—I. Mortality of the Operation. II. Results of the Operation.

I. Mortality of the Operation.—The latest statistics clearly show that though the severity of the operation has been much increased, its mortality is, *under the best conditions* (*vide infra*), very low. Thus, Sir W. M. Banks (*Brit. Med. Journ.*, 1900, vol. i. p. 823) gives a series of sixty operations without one death. Dr. Halsted (*Annals of Surgery*, Nov. 1894, p. 512) states that fifty of what he terms "complete" operations had been performed at the Johns Hopkins Hospital, Baltimore, and not a death had resulted from these operations. Mr. Watson Cheyne (Lettsomian Lectures, 1896, *The Objects and Limits of Operations for Cancer*, p. 34) had only one death in sixty-one cases, and thought that "the ether had probably as much to do with this death as the operation."

With regard to this very low mortality, it must be remembered that such results are the work of men of special experience; that cases in private as well as in hospital practice are included; and, lastly, in Dr. Halsted's case, the operator was working with very highly trained assistants.

When due attention and weight are given to such conditions as shock in an obese patient with poor cardiac fibre, lung trouble in a patient with chronic bronchitis, unavoidable sepsis as from an ulcerated* growth, the readiness with which this operation is undertaken, and the personal equation of the skill of the operators. it will, I think, be admitted that if all fatal cases were published, the death-rate would not be so low as that above given. It has, however, proved what can be done under the best possible conditions. But I would impress on my younger readers that it is not septic causes only which, nowadays, kill these patients; it is causes which, even when foreseen, no amount of care and caution will always prevent when an operation is forced upon us. I allude to bronchitis after an anæsthetic when the chest is hampered by bandages, and the patient, scarcely answerable for her actions, persistently slips down in the bed; to the failing strength and vitality with which the flickering light of the life of a patient with a fatty heart or albuminuria is snuffed out, it may be two or three weeks after the operation. Severity of operations rarely brings about a fatal result, unless the patient prove unamenable, another condition against which it is extremely difficult to guard.

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* Mr. Lockwood has drawn attention (*Traumatic Infection*, p. 51) to the grave importance of an ulcerating carcinoma as a dangerous source of septicæmia during the operation for removal of the breast. In his opinion (*loc. supra cit.*, p. 63) swabbing the surface of the ulcer with pure carbolic acid is not always reliable, and he vise destroying the entire surface of the ulcer with the actual cautery.

II. **Results of the Operation.**—It is clear, from the statistics which have been furnished (*vide infra*), that from 40 to 50 per cent. of patients submitted to the improved operation will be alive and apparently well three years and more after the operation. By many surgeons, some of them of eminence, this is looked upon and spoken of as tantamount to a cure.

Dr. Halsted (*Annals of Surgery*, Nov. 1898, p. 575) had operated on 133 cases by his improved method between June 1889 and April 1898. Of these 133, 76 had been operated on more than three years. Of these 76 operated on more than three years, 31 (41 per cent.) were living at the time of publication of the above article, without local recurrence or signs of metastasis.

Mr. Watson Cheyne (*Lancet*, 1899, vol. i. p. 757) from his cases concludes that by operating on wide lines 50 per cent. will remain free from recurrence.

Mr. Butlin (*Operative Surgery of Malignant Disease*, second edit., p. 404), from a collection of 47 cases operated on by Dr. Halsted, himself, Mr. Watson Cheyne, and Rotter, gives a percentage of over 50 cases "cured," *i.e.*, alive and well three years or more after the operation.

Sir W. Mitchell Banks (Lettsomian Lectures, "Practical Observations on Cancer of the Breast," *Brit. Med. Journ.*, vol. i. 1900, p. 823) tabulates 213 cases, "of which 175 are available for statistical comparison." Of these 175, 108 have remained free from local recurrence. Of these 108, 73 have lived over three years, as follows:—

Cases that have lived between 3 and 6 years after operation . . .	40
" " " 7 " 14 " " . . .	28
" " " 16 " 12 " " . . .	5

With regard to the **results of operation**, I must here again utter a caution, which I believe I was one of the first in this country to bring forward (in the third edition of this book), as to the use of the word "cure" in these cases. For some time past there has been an increasing tendency for leading surgeons, both English and American, to adopt Volkmann's teaching, and if three years have elapsed after an operation for cancer without recurrence, to look upon the patient as cured, and to speak of these cases as "cures." Such surgeons make light of any inaccuracy which it is admitted may be present in the above dictum, and they claim that, being "optimists," such a dictum is quite good enough for them, and that any other surgeons who hold a different view are to be looked upon as "pessimists." Now, there is one thing which is above optimism and pessimism, and that is the truth. What is the truth in this matter? It turns on what we understand by the word "cure," and —a matter of even greater importance—what our patients understand by it. No one, to my knowledge, has spoken to better purpose on this point than Mr. Sheild (*Med.-Chir. Trans.*, 1898, and *Diseases of the Breast*, p. 448): "As regards the prospect of a definite cure, as the term is understood by the public—*i.e.*, definite eradication of the disease, leaving the organism in a healthy state—it is the duty of a conscientious surgeon to be exceedingly cautious in pronouncing such definite opinions as have emanated from the German schools." And again, at p. 437: "Fresh manifestations of the disease locally, or in the bones or viscera, may occur at any period up to ten or fifteen years after the original operation. These may be termed fresh outbreaks of the disease, or what name any pathologist fancies, but the fact remains that the word 'cure' will be used with great caution by anyone who views the matter from the light of plain common sense, and a desire to act truthfully and conscientiously towards patients."

Being myself well aware of the variableness of cancer in its original rate of growth, its occasional long latency and then sudden re-activity, I look upon Volkmann's teaching as most pernicious, and on the adoption of his teaching—that if patients remain free for three years after an operation for cancer they may be looked upon as cured—as alike unscientific and dishonest, and unworthy of our profession. As Mr. Bennett in the discussion on Mr. Sheild's paper (*loc. supra cit.*) very forcibly put it: "It is perfectly certain that we cannot in any case of cancer promise what the patient understands by the term 'cure.' I cannot, therefore, escape from the conviction that if we are to use deliberately the term in relation to a three years' immunity from disease, we shall forfeit, I think deservedly, a great deal of that reputation for candour and honesty which we now possess."

Local Recurrence, when it occurs, is delayed by more Extensive Operations.—While we cannot honestly hold, without watching longer and publishing later the results of recent operations, that patients can count on a cure of the disease, there is no doubt that local recurrence is less frequent, and when it does take place it is delayed. Mr. Watson Cheyne put this matter strongly in his speech at the discussion on Mr. Sheild's paper: "After the Heidenhain-Stiles operation external recurrences have become much rarer, and in the majority of cases there is practically nothing left for the patient to die of but the metastatic deposits; and, further, in the absence of external recurrences, the patients live longer, and the internal deposits have time to grow and to become more noticeable."

To ensure such improved results the following conditions are essential:

A. To operate much more widely and thoroughly than is yet the rule, and thus to endeavour to remove every atom of tissue which recent researches have shown may be [illegible] isease. This will include (i.) removal of the whole [illegible] below will show to be far from (ii.) removal of the costo-sternal portion of the pectoralis major, and the pectoralis minor; (iii.) clearing out the axilla; and (iv.)—this is as important as any—the breast, the pectoralis major, axillary fat and glands, should be removed in one continuous mass.

B. **To exercise as far as possible a careful and judicious selection of cases.**

C. **To keep patients under supervision for a long time, and, at first, to see them at short intervals.**

A. **The operation to be much more wide and thorough than is yet the rule, in order to remove every atom of tissue which may be diseased.**

(i.) **Removal of the Whole Breast.**

Advocating, as I do most strongly, for reasons given above, the habitual performance of operations for cancer on the widest possible scale consistent with the patient's safety, I would draw attention to the following practical points bearing on the breast and the way in which cancer attacks it, which have been brought into prominence in recent years. (*a*) The breast is, in reality, a much more extensive organ than is usually believed. In addition to the well-known prominence, there is often a ring of outlying gland-masses of varying size and extent. Mr. H. J. Stiles, in a most helpful paper (*Edin. Med. Journ.*, June and July 1892), thus alludes to the latter point: "The breast tissue is not encapsulated into a compact body, but is so broken up and branched at its periphery that the stroma becomes directly continuous with the superficial fascia. There is, therefore, no capsule in the ordinary sense of the term." (*b*) The ligamenta suspensoria may contain breast tissue and lymphatics. Both these facts make clear the futility and risk of niggardly skin-incisions. (*c*) There are often lobules of breast tissue intimately connected with the pectoral fascia. These are certainly left behind if the breast is merely separated from the pectoral fascia, as is often done. (*d*) A deep lymphatic plexus or lymph path runs in this fascia from the breast towards the axilla. Volkmann was the first to teach prominently that it was right to remove entirely the pectoral fascia. Prof. Halsted thus quotes from Volkmann's *Beiträge zur Chirurgie*: "I was led to adopt this procedure because, on microscopical examination, I repeatedly found, where I had not expected it, that the fascia was already carcinomatous, whereas the muscle was certainly not involved. In such cases a thick layer of apparently healthy fat separated the carcinoma from the pectoral muscle, and yet the cancerous growth, in places demonstrable only with the microscope, had shot its roots along the fibrous septa down between the fat lobules, and had reached and spread itself out in flat islands in the fascia. It seems to me, therefore, that the fascia serves, for a time, as a barrier, and is able to bring to a halt the spreading growth of the carcinoma."

The above points in the structure of the bosom, which explain how easily outlying and deeply placed deposits of cancer may escape niggardly and superficial operations, will explain many of the steps enjoined below in the account of removal of the breast.

Mr. Stiles (*loc. supra cit.*) believes that " [illegible] carcinoma after removal of the breast is usually du [illegible] east being in a pre-cancerous state, but to the [illegible] microscopic foci of cancer, more or less remote from the main tumour, and depending for their origin upon the arrest and growth of cancerous emboli disseminated more or less directly from the primary tumour along the lymphatics.* The importance of removing all the retro-mammary tissue, pectoral and axillary fascia, axillary fat and glands, along with the breast, in all cases of carcinoma, cannot be too thoroughly insisted upon or too often repeated. The anastomosis and intersection of the lymphatics are so free that it is impossible to say towards which set of glands the lymph from any given point in the breast will be conveyed. I have seen cancerous lymphatic emboli at the axillary border of the mamma when the tumour was situated in the inner hemisphere, and *vice versâ.*" †

The following cases, from an important paper by Mr. Raymond Johnson, read before the Pathological Society (*Brit. Med. Journ.*, 1892, vol. i. p. 70), illustrate how unsafe it is to leave any portion, however small, of a breast the seat of malignant disease—not only, as shown by Mr. Stiles, on account of the frequent presence of minute foci of cancer, remote from the main growth, but also because changes of a pre-cancerous nature may be going on in parts of the breast not yet actually attacked by carcinoma.

In a case of infiltrating carcinoma in a woman, aged 27, microscopical examination of parts of the breast, which appeared normal to the naked eye, revealed masses of cancer cells apparently lying in lymphatic spaces. In another specimen of the infiltrating variety the microscopical appearances strongly suggested that widespread carcinomatous change was involving the whole organ, sections showing the new growth arranging itself around the small ducts which were themselves normal. In the case of a woman, aged 34, a small nodular carcinoma was situated at the axillary border of the left breast. After removal two small nodules were found at the sternal end of the gland, each having the typical structure of glandular carcinoma, whilst microscopical examination of the central part of the breast showed marked proliferative changes in the epithelium of the acini, these changes probably standing in the same relation to cancer of the breast as chronic superficial glossitis does to cancer of the tongue, namely, a possible pre-cancerous condition.

Heidenhain, in a most valuable paper ("Ueber die Ursachen der localen Krebsrecidive nach amputatio Mammæ," *Verhandlungen der*

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* Mr. Stiles's observations lead him to recognise five sets of lymphatics in the bosom: (1) a cutaneous set including those of the nipple-areola and surrounding skin; (2) sub-areolar; (3) intra-mammary; (4) in the circum-mammary fat; (5) retro-mammary.

† In order to afford the surgeon an additional means of ascertaining the limits of the breast and of the disease, Mr. Stiles (*loc. supra cit.*) recommends the use of nitric acid, which, rendering the parenchyma of the gland and carcinomatous tissue dull greyish-white and opaque, causes the smallest specks of both to stand out from the fat and connective tissue in which they are embedded, the fat remaining unaltered and the connective tissue becoming translucent and somewhat gelatinous. Immediately after removal the breast is placed (all the blood being first washed off) in from one to two pints 5 per cent. nitric acid solution for about ten minutes, and then washed in running for three or four minutes. This examination can be completed before the wound d.

Deutschen Gesellschaft für Chirurgie, Berlin, 1889), teaches that in breast cancer there are proliferative changes in the lobules throughout the whole gland, which must be looked upon as the direct forerunner of cancer ("das mittelbare Vorstadium der Krebsentwickellung"), and which sooner or later pass into cancer

On this account, believing that whether the whole breast is, in the great majority of cases, in a condition to become carcinomatous or not, partial operations are liable (especially when the coarse fat, which is often so abundant, and the hæmorrhage in the operations are remembered) to leave behind potential foci of disease, I consider that more wholesale operations are, in these days of modern surgery, absolutely essential.

(ii.) **Removal of the Costo-sternal Part of the Pectoralis Major and the Pectoralis Minor.**—The need of this step is still disputed. Dr. Halsted in every case removes the whole thickness of the pectoralis major except its clavicular portion, and divides in all, and in most cases removes, the minor as well. His reasons are as follows:—(*a*) It has been microscopically proved by Volkmann and Heidenhain that repeatedly a cancer of the breast, though freely movable on the subjacent parts and separated from the muscle by a layer of fat apparently healthy, has reached and spread out in the fascia over the pectoralis major. Removal of the costo-sternal part of the pectoralis major is the surest method of getting quickly rid of this fascia. (*β*) It facilitates the removal of the disease in one piece, which is so essential (*vide infra*, pp. 658, 667, and Fig. 231). (*γ*) This step does not increase the danger of the operation; that this is so in Dr. Halsted's hands is shown by the very low mortality in his paper (*vide supra*), published in 1894, viz., 76 cases without one death. (*δ*) The impairment of usefulness of the upper extremity, due to the operation, is but little increased by the above step. "In most cases the arm of the side operated upon has been quite as useful as before the operation. Some of the patients, when questioned, complain that they cannot dress their back hair. This disability is due to the loss of skin, and not to the loss of muscle." The above small impairment of usefulness Dr. Halsted attributes to his securing primary union of the axillary end of the wound, and thus an absence of fixation of the arm to the side by his flap (Fig. 229). With regard to those cases in which there is some impairment of usefulness, all will agree with his remark: "After all, disability, ever so great, is a matter of very little importance as compared with the life of the patient."

With regard to the pectoralis minor, Dr. Halsted always divides this, and sometimes removes it, because "the tissue over it, more or less rich in lymphatics, is often cancerous," and because under it run small blood-vessels embedded in loose connective tissue which seems to be rich in lymphatics and contains more or less fat. This fat is often infiltrated with cancer."

On this point of how far the mobi [illegible] ar[illegible] [illegible]paired I would refer my readers to Fig. 232, taken [illegible] in which both breasts and both pectorals on each [illegible]

On the other hand, the necessit[illegible] muscles is denied by several autho[illegible] *supra cit.*, p. 84) entirely dissents fr[illegible] of the greater [illegible] is not neces[illegible] axillary contents. "If the arm be properly manipulated, and the great pectoral dragged upwards and inwards, the very topmost point of the axilla can be cleared out." And again, with regard to involvement of the muscle: ". . . One word more in reference to removing the great pectoral muscle. Do cancerous recurrences take place in the substance of that muscle? Are they found in the interval between the great and small pectoral muscles? Taking the latter query first, I have never seen such an occurrence. Referring to the first, I believe that when the great pectoral muscle is the site of recurrent growths they creep into it from the subcutaneous tissue and pectoral fascia. They do not primarily originate in the muscle. There is therefore no need for its removal on that ground." Mr. Watson Cheyne (*Lancet*, vol. i. 1899, March 18, p. 757) only takes away that part of the pectoralis major which lies beneath the growth, removing the whole costo-sternal portion in those cases alone in which it is evidently diseased. He maintains that he can completely expose the axilla without removal of the costo-sternal portion of the muscle. Removal of the pectoralis minor he looks upon as quite unnecessary, as it can easily be drawn upwards and downwards, and the whole of the axilla readily cleared out. For myself, knowing that in the majority of cases cancer of the breast is not brought to the operator until it is no longer limited to the breast itself, feeling also that the growth may have invaded the sheath though the fat over this appears healthy (p. 656), that it may also have invaded the muscle itself though invisible to the unaided eye, having found for myself that a free removal of the muscle facilitates clearing out of the top of the axilla, and feeling that though this wide operating leads to a thicker, denser scar, and therefore in some cases to impaired abduction and elevation of the arm, this must not weigh against any step that may help in extirpation of the disease, I advocate entire removal of the costo-sternal portion of the pectoralis major in all cases, with very few exceptions. It ought certainly to be removed in those cases, as I stated in the last edition of this book, which come for operation in the second stage (and how very many do so!); in cases where infected glands lie along the sheath of the vessels, and where such glands can be felt between the pectorals or high up in the axilla. When the patient is feeble, or has chronic bronchitis and a weak heart, the decision as to removal of the costo-sternal part of the muscle will depend upon the way in which the anæsthetic is taken, the condition of the pulse, and the amount of skilled help that is to hand. For free removal of the above part of the muscle leads to additional hæmorrhage and to some increase of the shock.

As to removal of the pectoralis minor, I agree that when this muscle is but little developed, as is usually the case, the axilla can be cleared out, by efficient use of retractors, without division of the muscle. But the fatty cellular tissue over and under it is so delicate, and, on Dr. Halsted's authority, is so liable to be infiltrated, that removal of the [illegible]cle certainly facilitates clearing this tissue away thoroughly.
al of this muscle will not add to the impaired mobility of the
it does leave a deeper, more irregular floor to the wound,
ischarges may collect if it be not left dry. For the same
diate grafting is rendered less easy—a matter of minor
it is wiser to defer this step (p. 672).

Mr. Steward has handed me the following remarks, which have an important bearing on this question of the advisability of removing the muscles, as advised by Dr. Halsted:—"The published results clearly bring out the fact that Prof. Halsted's operation does most to prevent *early* local recurrence. This will be seen at once by comparing the following figures:—

Surgeon.	Operations.	Percentage of local recurrences within three years.
Banks ...	165	29
Cheyne ...	61	18
Halsted ...	76	9

I have here included only cases of *local* recurrence, in order that the efficacy of the particular method of operating as regards the removal of the whole of the infected tissues may be gauged. This, I hold, is the correct way to gauge the success of a method, for recurrence in other parts of the body than in the site of the operation clearly cannot be influenced by the operation, since it must be due to dissemination having taken place previous to the operation."

(iv.) **The Need of Clearing out the Axilla in Every Case.**—This has been increasingly accepted of late years, and is now almost universally acted upon. It is acknowledged that the axillary glands may be extensively involved without any external evidence; nay, more, the microscope has shown that axillary contents, apparently normal to the unaided eye, have been the seat of extensive cancerous deposit. We know now that opening and clearing out the axilla does not add to the risks of the operation as long as due precautions against sepsis are taken. Cases are still occasionally quoted in which, though the axilla was never opened, the disease has not appeared there for many years, as long as the patient was kept under observation. The answer to this, as an argument against a routine practice of clearing out the axilla, is very simple. We must admit that such cases exist, but they are extremely few. Possibly, in 100 cases in which the axilla has been cleared out as part of the thorough operating of the present day, in four or five this step might be superfluous, as the disease had not reached the glands. But which of the 100 were these four or five? Does anyone pretend for a moment that our knowledge of cancer of the breast enables us to select them before operation? (Watson Cheyne.)

(v.) **The Whole of the Disease should be Removed in One Continuous Piece** (Fig. 231).—The following are Dr. Halsted's words (*Annals of Surgery*, Nov. 1894, p. 507) on this point, and it will be seen that to achieve this object is one of his chief reasons for removing the pectoralis major:—"The pectoralis major, entire, or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled thereby to remove in one piece all of the suspected tissues. The suspected tissues should be removed in one piece (1) lest the wound become infected by the division of tissues invaded by the disease, or of lymphatic vessels containing cancer cells, and (2) because shreds or pieces of cancerous tissue might readily be overlooked in a piecemeal extirpation." And again, p. 510: "All that is removed is in one piece (Figs. 230 and 231); there are no small pieces or shreds of tissue. I believe that we should never cut through cancerous tissues when operating if it is possible to avoid doing so. The wound might become infected with cancer either by the knife which has passed through diseased tissue, and perhaps carries everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli, or from the lymphatic vessels. The division of one lymphatic vessel and the liberation of one cell may be enough to start a new cancer."

Sir W. M. Banks (*Brit. Med. Journ.*, vol. i. 1900, April 7, p. 822) dissents from the above opinion: "A view is now being taught that there is great danger of infecting the wound with the knife that has made the exploratory incision through the tumour. I have seen no evidence whatever to this effect, and the extreme difficulty of getting the strongest cancer-juice to reproduce anything in any cultivation medium is not in favour of it. If the operator is afraid of such a contingency let him wash his knife."

With all deference to the authority of Sir W. M. Banks, I am of opinion that as we know so little of the causation of cancer, and as the proportion of the cell elements in cancer varies so much, we shall do well to adopt every possible precaution.

B. A careful and judicious selection of cases.

I. *Cases in which an Operation is Indicated.*—(1) Cases somewhat advanced in life; for the younger the patient the more active is the cancer. (2) Especially if patients who are on in years are thin and dry and tough, clear-voiced and bright-eyed, with good pulses and digestion, and no cough or wheezing. (3) Small breasts and little fat. (4) Where the growth is circumscribed with a distinct outline. The worst defined tumours are the worst for recurrence. (5) Where the growth is very hard. The "stoniest" growths are usually the slowest. (6) Skin not involved. (7) Absence of fixity. (8) Either no axillary glands, or but very few, involved. (9) Rate of progress slow, and family history good.

II. *Cases to which an Operation is altogether Unsuited, or especially Doubtful and (in many) Dangerous.*—(1) The aged—*e.g.*, after seventy; not only are the aged less healthy, but they are less troubled by the cancer, and more resigned. (2) The unhealthily fat* and plethoric. (3) Habitual over-eaters. (4) Tipplers on the sly. (5) The subjects of a confirmed bronchitis, and weak heart. (6) Subjects of decided albuminuria, cirrhosis, or diabetes. The first two of these should prohibit operation. Where glycosuria is present the prognosis will depend on how far the amount of sugar is affected by treatment.

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* Sir James Paget, from whom many of the above have been taken, thus wrote (*Clin. Lects. and Essays*, p. 14): "The over-fat are certainly a bad class, especially when their fatness is not hereditary, but may be referred in any degree to their over-eating, soaking, indolence, and defective excretions. The worst of this class are such as have soft, loose, flabby, and yellow fat; and I think you may know them by their bellies being pendulous and more prominent than even their thick subcutaneous fat accounts for, for this shape tells of thick omental fat and, I suppose, of defective portal circulation." Some earlier remarks of Sir James may here be quoted: "Such people must be carefully managed—not fed too well; not kept too long in bed; not allowed to retain their refuse; and mere bigness must not be taken for plethora."

Where treatment has no effect, and where the operation must be an extensive one, it must be clearly put before the patient and her friends that the risks are much increased. I allude to shock and the risk of sepsis from sloughing, in such a case, of flaps freely undermined. Mr. Sheild (*Diseases of the Breast*, p. 422) speaks more hopefully: "In cases of glycosuria extra pains must be taken to avoid sepsis. If this be done, the sugar in the urine is no bar to a needful operation, though it must of necessity make the prognosis more serious, and this must be especially stated." (7) Extensive disease of the skin, accompanied by scattered tubercles, or œdema, or a condition of erythema (this is the cancer-erythema to which Mr. J. Hutchinson has drawn attention); and, worst of all, a brawny, leather-like, greasy condition of the skin, with firm œdema and open sebaceous glands, approaching the condition of cancer *en cuirasse.* (8) Quick growth, with rapidly increasing fixity. (9) Supra-clavicular disease. When this condition is present the general opinion of surgeons has been that the disease has taken too extensive a hold, and that operation is useless. Dr. Halsted has lately (*Annals of Surgery*, Nov. 1898, p. 570) advocated operative interference. His rule would be to operate on the neck in every case.* This operation is not postponed, as it can never be done so well as at the first opportunity when the axilla is opened, the subclavian vein fully exposed, and the clavicle free. This bone is not now divided as in former years, "for simple division of the clavicle does not facilitate the dissection much, if any, and the removal of a piece of the collar-bone is a procedure which maims without sufficient compensation." The dissection is begun at the junction of the internal jugular and subclavian veins, and the supra-clavicular fat and lymphatics cleared away by working from within outwards and from below upwards. The great majority of surgeons are against this step. Sir W. M. Banks (*loc. supra cit.*, p. 821) writes: "I have given up attempting to get any good out of clearing out the supra-clavicular fossa. In former days, when I thought I could remove any cancer, I did a good many cases, but never one survived. . . . My notion is that when cancer has laid hold of the supra-clavicular glands it has got such a grip as to be past extirpation." Mr. Butlin's opinion (*Operative Treatment of Malignant Disease*, second edit., p. 399) is as follows: "I have not been in the habit of removing the supra-clavicular glands, certainly not as a routine part of the operation for cancer of the breast. The operations which are now performed are so extensive that any addition to them is fraught with danger. If the glands above the clavicle are to be removed, I think it would be wiser to do this when the patient has recovered from the larger operation. If they are actually cancerous, I believe that the case is hopeless as far as radical cure of the disease is concerned. And that is an opinion which is shared by most operators at the present time." Mr. Watson Cheyne (*Lancet*, vol. i. 1899, p. 757) would only clear out the posterior triangle if he found the fat which runs up behind the axillary vessels and nerves in the direction of the posterior triangle infected with enlarged glands. If the glands behind the sterno-mastoid in the root of the neck are implicated—and this is much the most common glandular infection in the posterior triangle—he would not interfere, "as the results do not justify operation." My own view on this matter is, that where the supra-clavicular glands are enlarged a radical cure is out of the question. The only evidence of any value which we learn from Dr. Halsted's statistics* on this point is that two of the cases in which the supra-clavicular region was cleared out were alive and well three and three and a half years respectively after the operation on the neck, which was here a secondary one.

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* *I.e.*, whether enlarged glands can be felt or no. His statistics are quoted below, p. 661.

With regard to the statistics given here, the following remarks by Dr. Coley in his article on Cancer (*Twentieth Century Practice of Medicine*) are noteworthy: "The only positive evidence Halsted's statistics afford us as to the value of this operation of cleaning out the supra-clavicular fossa rests upon two cases in which the operation was done secondarily, and in which the patients remained well three and three and a half years after the operation. In view of what I have already said regarding the failure of a three-year limit as establishing a cure of the disease, we cannot consider the question as settled without much stronger evidence."

To those who agree with what I have said about the value which, in my opinion, is to be attached to this three years' limit of Volkmann's (p. 653), it will be clear that much more evidence is required before we can come to a conclusion on this matter. But there is one point which appears to me to negative success, and that is, that in dealing with disease here it is impossible to follow the cardinal rule on which Dr. Halsted has himself laid so much stress, viz., to get out the disease in one continuous piece. Where the disease has reached only a few of the axillary glands, and these the lower ones, careful operating on wide lines may succeed in extirpating it in its continuity. But where it has extended above the clavicle, I believe that it is impossible to follow the above most essential rule. There will always be an infected lymphatic tract running between the two regions behind the clavicle, and even removal of this bone—itself no slight operation—will not enable us to extirpate the above tract, considering what its relations are, however carefully the dissection is carried from below and above, and however much the shoulder be raised and depressed.† But, while I believe that radical cure is hopeless when the supra-clavicular glands are enlarged, I consider that operation is justifiable, both as a primary and a secondary step, if the object of the operation be honestly explained to the patient or her friends. I have myself twice performed it, in both cases as a secondary operation. In one case the patient lived three years, in the other fourteen months, after the operation. Glands in this space will, I believe, usually be found to enlarge slowly, and, as the space is relatively large, they do not become adherent quickly. If the operation is a primary one, it should not be performed at the same time as that for removal of the breast, but from ten to twenty-one days later. Clearing out the posterior triangle is a difficult and trying operation, especially in its lower and inner regions, and, both for the patient's and surgeon's sake, it should not follow at once on an operation like the modern one for removal of the breast. I am aware that Dr. Halsted (*loc. supra cit.*) undertakes both these operations, together with Thiersch's grafting, when this is needed, at one and the same time. "Two to four hours" are required, but it is to be remembered that he can always count on "highly trained and skilful assistants." (10) A young patient, especially with a voluminous breast, a rapidly increasing growth, and a bad family history. (11) Of course, the presence of carcinoma elsewhere—*e.g.*, uterus—or secondary deposits in the liver, pleura, and bones. Mr. Sheild's advice (*Diseases of the Breast*, p. 393) should be remembered: "Vague pains, supposed to be 'rheumatic,' should always lead to an examination of the bones, and the contents of the thorax and liver should receive methodical investigation." That operation is not absolutely contraindicated where both breasts are involved is shown by a case of Mr. Page's (*Brit. Med. Journ.*, 1888, vol. ii. p. 937):

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* The supra-clavicular fossa was cleared out in 67 cases, 53 being primary and 14 secondary operations. Of the 53 primary operations, in 12 the supra-clavicular glands were involved; of the subsequent history of these we are told nothing. Cancer was found in the tissues removed 23 times, or in 34 per cent. of these cases. In 30 cases there was no cancer, and in 14 the result was uncertain, as the tissues removed had not, at the time of publication of Dr. Halsted's paper, been submitted to the regular exhaustive examination which his specimens undergo.

† It is the same with cancer of the tongue when the glands in the neck are invaded. I have long taught that radical cure is here almost hopeless, owing to the great difficulty in extirpating the lymphatic tract which lies behind the jaw and in the floor of the mouth. It is noteworthy that Mickulicz (*Twentieth Century Practice of Medicine*, vol. ix. p. 79) writes on this point: "I regard the prospect of radical cure as excluded as soon as the deep glands of the ne

Here both breasts were the seat of carcinoma, and both were simultaneously operated on by Mr. Page and Mr. Silcock. The patient, aged 68, made a good recovery. The case of mine illustrated in Fig. 232 may also be referred to.

(12) Cases in which the axillary vessels and nerves are clearly involved in a mass of growth. (13) Pregnancy and suckling. When these complications are present in cancer of the breast two questions arise. One refers to the diagnosis. In these cases the cancer is likely to be associated with evidence of inflammation, and to be mistaken for acute mastitis. The following points should be investigated: "The skin has a peculiar erythematous blush upon it (cancer-erythema, Hutchinson), which spreads over the skin of the mamma and thorax, gradually fading off into the surrounding tissues. There is local heat and tenderness, and the bodily temperature is raised. A close inspection of the skin usually declares the true nature of the case, for it is infiltrated with cancer over the breast, and has invariably the 'bacon rind' or 'peau d'orange' appearance. The lymphatics of the integument may be markedly implicated, so that they stand out as white cords and nodules of a yellowish or white and pearl-like aspect" (Sheild, *Diseases of the Breast*, p. 358). With regard to operation, the prognosis* is extremely unfavourable when the patient is either pregnant or suckling. If the

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* There are no worse cases for operation than those in which malignant disease supervenes on mammary abscess and induration in suckling women. The more vascular the breast and the more abundant the fat, the more difficult will it be to make certain of extirpating not only the growth but also every atom of the breast. Speaking of vascularity, I have been asked if removal of the breast is justifiable in hæmophilia. My answer would be a decided negative.

patient be comparatively young, there is much vascularity and activity of the lymphatic circulation, and hence a very high degree of malignancy. However free the removal, return in the adjacent area is extremely probable, together with secondary deposits. If the patient survive, the other bosom may not improbably be attacked. The outlook should be put before the patient. If operation be decided upon, the risks of abortion or premature labour must be faced. The late Sir W. S. Savory (*Brit. Med. Journ.*, 1883, vol. ii. p. 167) gives cases in which the breast was removed, in the one case in a woman four months, in the other seven months, pregnant. Both cases recovered rapidly from the operation.

III. *Cases in which an Operation is Doubtful.*—These lie intermediate between I. and II., both as to the general and local points.

Operation* (Figs. 223-232).—The **chief objects** to be borne in mind throughout the operation have been given at p. 654.

Owing to the age of many of these patients, their confinement to bed, and the restricted position which lies before them, especial care should be paid to the state of the bowels and kidneys, and any bronchitis, however slight this appears to be, should be treated. The parts having been sterilised, and a compress put on securely some hours before the operation, the patient's neck and abdomen are well protected with mackintoshes with warm towels beneath, while sterilised towels are securely packed around the area of the operation, and one wrapped round the patient's hair. Where the patient is weakly, the subject of any bronchitis, the warmth of the trunk and lower limbs should be carefully looked to.* On a cold day the room should have a temperature of 70°. The operation should not be performed on a foggy day. The surgeon should be prepared at every point by the time that the patient is anæsthetised.

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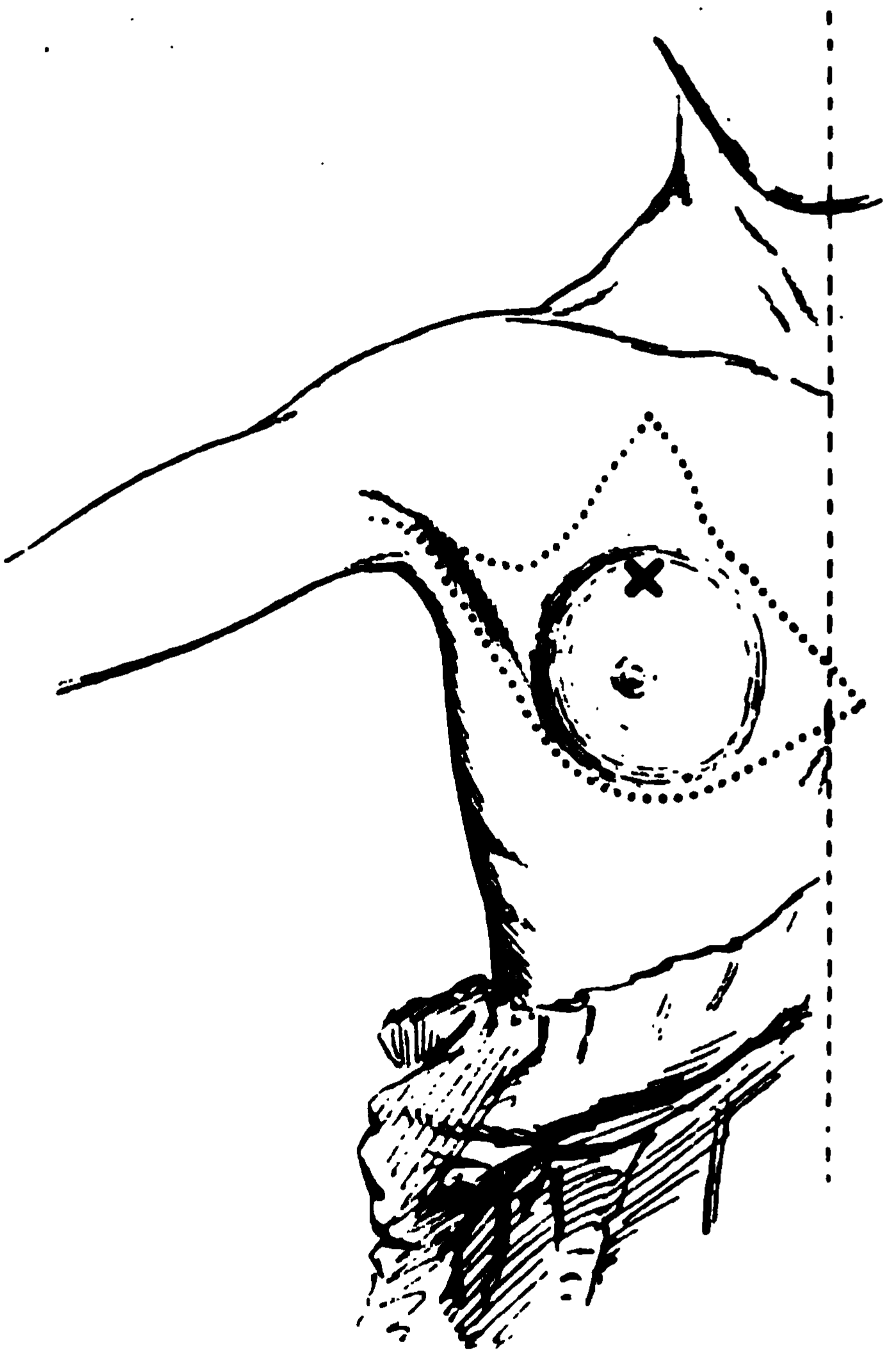
* By some the above operation is called "the complete operation." Till the cases submitted to it have been watched for a much longer period than three years, the period too often considered sufficient (p. 653), it will be wiser and more honest not to write of operations on cancer as complete. By others the operation is described by the name of some operator—*e.g.*, Dr. Halsted. I have given this surgeon's operation *verbatim* later on. Mr. Watson Cheyne, in the discussion on Mr. Sheild's paper (*Med.-Chir. Soc. Trans.*, Feb. 22, 1898), considered that as Heidenhain and Stiles had described the pathology and mode of spread of breast cancer, and shown in full detail what must be done as regards operation, before Halsted wrote, the operation should be called the Heidenhain-Stiles operation, "after the men to whom the whole credit of it is due." To give the name of any operator to an operation which, not a new one, has been built up by the labours of many, and which owes its present improved *technique* very largely to the advances of aseptic surgery, appears to me to be unwise, and to involve injustice to others. The tendency nowadays to talk and write as if the origin of the modern operative treatment of cancer of the breast dated to the labours of Heidenhain, Stiles, and Halsted, ignores most unfairly the work of others who should not be forgotten. And one name at least—that of an English surgeon—rises pre-eminently as a worker in this field. I refer to Sir W. M. Banks. For twenty-three years this surgeon, with unfailing earnestness and characteristic vigour and terseness of expression, has in many places urged the need of more extensive operations in this disease. I refer to his papers—"A Plea for the more Free Removal of Cancerous Growths," 1877; "On Free Removal of Mammary Cancer, with Extirpation of the Axillary Glands as a Necessary Accompaniment," 1882; "Extirpation of the Axillary Glands a Necessary Accompaniment of the Removal of the Breast for Cancer," read before the Harveian Society in 1887: a paper which deserved a much more comprehensive title, as, in it, several points of which we have lately heard so much, viz., removal of the disease in one continuous mass, and the need of division of the pectoralis major, are dealt with. These papers are mentioned in the Lettsomian Lectures of Sir W. M. Banks (*Brit. Med. Journ.*, April 7, 1900), and prove that if honour is to be given where it is due a fair share of it must justly fall to him.

It will be well to allude here to a preliminary point of much importance. Let it be supposed that the case is one of doubtful diagnosis, whether one of cancer, chronic mastitis, or cyst. While, personally, I hold that when chronic mastitis, which has resisted judicious treatment, is present, the patient being at a cancerous age, is rendered much safer by removal of the whole breast (p. 656), and the same is true of many cases of cysts, where this condition does not occur singly, the operator's hands are sometimes tied, and he is pledged to save the bosom if possible. In such cases—and here the patient must take the entire risk—in making any exploration to clear up the case, the surgeon should follow Mr. Watson Cheyne's advice (*Lancet*, 1899, vol. i. p. 757), and make not an incision into the supposed growth, but an excision of it, with a margin of apparently healthy tissue, as

Fig. 223.



This and the next four figures illustrate the incisions recommended by Mr. Watson Cheyne. In the first three, angular incisions are shown in addition to the widely elliptical ones. X marks the site of the supposed cancer.

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* Whenever possible the patient should lie, protected by a blanket, on hot water either in a tank as part of the operating table or in a water-bed.

the risk of auto-infection is not a mere theoretical danger. If more requires to be done the wound is rapidly sutured, and the hands of the operator and any instruments used are re-sterilised.*

The patient being brought to the edge of the table,† and raised on a pillow to a height convenient to the operator, the arm is sufficiently‡ abducted to open out the axilla, and fastened or supported in this position. The surgeon then examines the probable extent of the breast,§ and determines the site of his incisions. It is well not to be tied to any constant rule here. The following will give sufficient choice:—A. The usual elliptical incisions, employed on a very wide scale. B. The same, with angular incisions superadded, as in Figs. 223 to 225, when the surgeon has to deal with a growth lying near the periphery of the breast. C. The incision adopted by Dr. Halsted (Figs. 229 and 230). I will suppose that the growth is near the centre of the bosom, and that on the right side. For such a case the usual elliptical incisions, if used on a very free scale, are well adapted. But the above proviso must always be acted upon. Recurrence of the growth *in situ*, always discreditable to the operator, is usually due to leaving some breast tissue or infected skin behind. To avoid this risk the whole of the skin over the affected breast, however small the growth appear to be, should be removed. To effect this the lower incision (always to be made first) starts from the apex of the axilla below the anterior fold, sinks downwards over the seventh rib in the mid-axillary line, then, passing below the lower border of the breast, curves upwards to the sternum. An assistant, who stands opposite to the surgeon, now draws up the breast, while the surgeon, taking the cut margin between his left finger and thumb, dissects downwards an extensive flap. In doing this he must take just sufficient fat to maintain the vascularity of his flap. If he take more than this, lobules of breast tissue, possibly infected, are very likely taken also, these being difficult to distinguish from their surrounding fat as soon as blood begins to flow. If less be taken, sloughing of the fat, and very likely a condition of sapræmia, is extremely likely to follow. In making either of the elliptical incisions the knife should not pass down to the muscles at once. A considerable area of fat and fascia is to be left, to be removed at the next step, in order to make sure of removing the whole bosom, the description of which according to the text-books as always definitely encapsuled is not absolutely reliable. As the flap is raised, Spencer Wells's forceps are applied to every bleeding point. The bosom being next drawn down, the upper elliptical incision is made between the extremities of the first, passing above the upper limit of the breast. An upper flap is raised in the same way as the lower one, and dissected up to within about an inch and a half of the clavicle. Bleeding vessels are here also quickly secured with forceps, and as each batch accumulates they should be tied off with fine sterilised silk. If it be objected that incisions made on such wide lines will prevent primary closure of the wound, the answer is, that only by operating on such lines is extirpation of the disease to be hoped for. and recurrence, especially its worst form *in situ*,* to be prevented, and therefore primary closure of the wound is scarcely to be considered at this stage. It will be shown by details given later (p. 671) to what a large extent primary closure may be secured even in these hugely gaping wounds.

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* This word reminds me to mention the advice of Mickulicz, that during this and any prolonged operation the surgeon and his chief assistants should be careful to re-sterilise their hands from time to time.

† This step, aided by careful packing of the towels, will diminish the tendency of blood to trickle backwards beneath the patient.

‡ It will be remembered that the more the arm is abducted and elevated the more superficial do the axillary vessels become.

§ Where the bosom is large and pendulous it must be raised before the line of the lower incision is determined upon.

The surgeon next lifts the breast away from the chest wall, and proceeds to detach the outlying zone of fat, working from the sternum to the axilla, and from below upwards. This is effected either with a scalpel or, as I prefer, with blunt-pointed scissors. The parts being rendered tense by lifting up the breast, every atom of fat and fascia in the above-mentioned zone is removed. As this is done the top of the external oblique and the serratus magnus below and the latissimus dorsi externally are uncovered. The lower border of the pectoralis major is soon reached. The costo-sternal part of this is now removed by cutting through the muscle† just outside the sternum and along the ribs, detaching it with the breast from without inwards, then defining the interval between the clavicular and costo-sternal portions, and finally severing

FIG. 224.

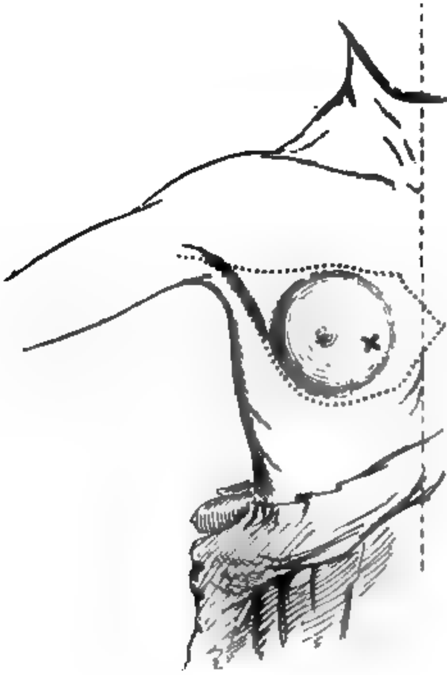
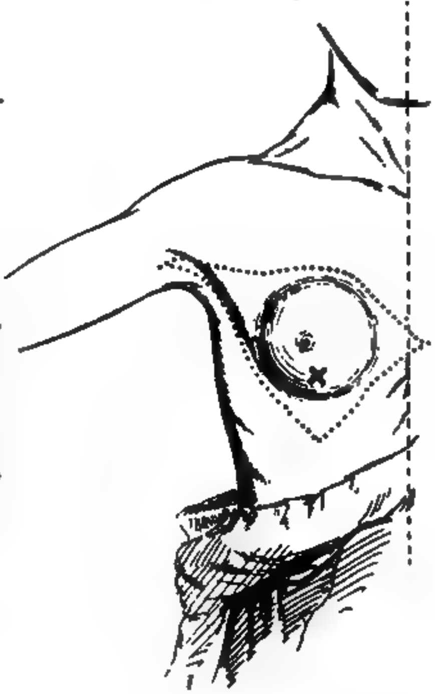


FIG. 225.



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* Because now the recurrence is constantly visible to and dwelt on by the patient.

† In severing and detaching the pectoralis major, care must be taken not to injure the costal cartilages, or tedious exfoliation may follow.

the muscle close to its humeral attachment. The question of thus removing the costo-sternal part of the pectoralis major has been already discussed at p. 656. If the operator remove only that part of the pectoral which lies under the breast, he has excellent authorities behind him. But he must make certain that he does remove all such part of the pectoral. As pointed out at p. 654, Volkmann has shown that a deep plexus of lymphatics lies in this fascia, and that it is never safe to leave this structure, as it is quite impossible to tell with the unaided eye whether it is involved or no. Any attempt to remove the fascia from the muscle is to be condemned as certain to leave some of the fascia behind; while from the oozing which attends any such attempt more blood is lost than when the muscle is itself removed.

Fig. 226.

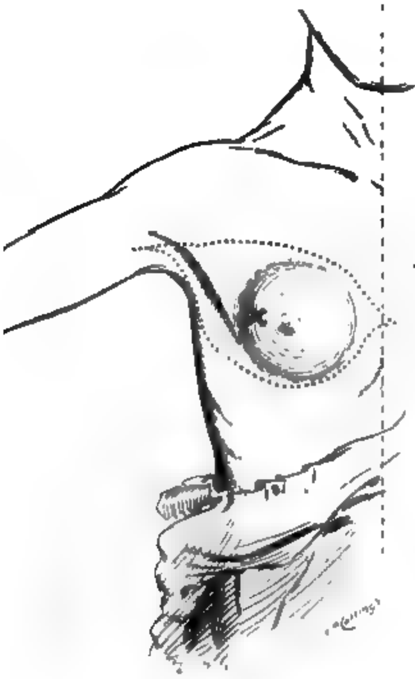
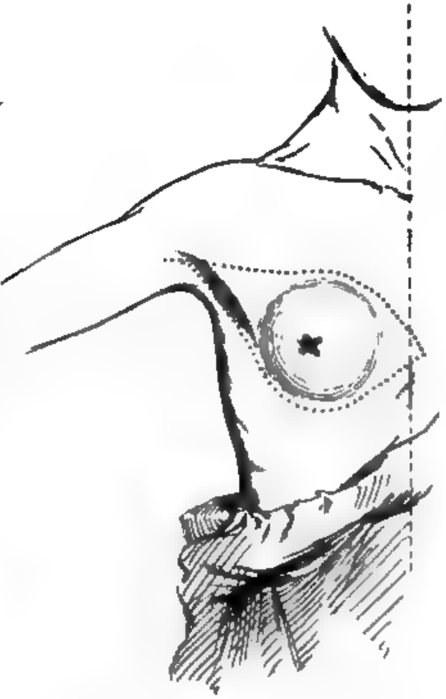


Fig 227.



The whole mass—breast with overlying skin, the adjacent zone of fat and superficial fat and fascia (as far as this has been removed) below, the pectoralis major—is now raised, if the breast be a large one, by an assistant, so that both the surgeon's hands are free for the delicate work which comes next. The mass is manipulated by the surgeon or an assistant with the twofold object of keeping it out of the surgeon's way and also of putting on the stretch the different structures which have yet to be removed. All along it should be remembered how essential it is to get the disease away in one continuous mass. The cut clavicular part of the pectoralis major is next raised with a broad-clawed retractor, and the loose tissue beneath it carefully dissected from the muscle. "This tissue is rich in lymphatics, and is sometimes infiltrated with cancer" (Halsted). The mass of breast, &c., being carried outwards, the fatty tissue is stripped from the thoracic wall, close to the ribs, down to the pectoralis minor. This muscle is then divided and removed at its origin and insertion, so as to make certain of getting away the very delicate fatty tissue on it and beneath it, which, as Dr. Halsted has pointed out, is rich in lymphatics and often cancerous. Any surgeon in doubt as to the removal of the lesser pectoral muscle will have referred to the remarks at p. 656. The first part of the axillary and the termination of the subclavian vein is now exposed at the highest possible point (Fig. 230), and the sheath and overlying fatty tissue are carefully removed from the axillary vein in its whole length, and with these the fat and glands in the axilla, according to the directions given below. Dr. Halsted's cautions at this stage should be remembered.

The numerous small veins which will be met with now should be carefully tied, owing to their delicacy, close to the axillary vein, and "no particle of extraneous tissue should be included in the ligature" of these and other vessels. On no account is the operator to pull out the glands and fat from the axilla with his fingers—a step certain to leave infected tissues behind. The need of getting away the disease in one continuous whole is now especially to be remembered. In cleaning the sheath a scalpel should be employed, but for the rest I prefer blunt-pointed slightly curved scissors, which serve not only for cutting but for separating structures.

Great care is needed in cleaning the fatty tissue, and especially so, if enlarged glands are present, from the axillary vein. If this trunk be injured a purse-string stitch taking up the opening is very difficult to apply; leaving on a pair of Spencer Wells's forceps is not reliable; and ligature of the vein below and above the opening will probably be required. This is spoken of by some operators as a slight matter, and as one which will not cause after-trouble. In two cases in which, to get away adherent glands, I was compelled to remove a portion of the axillary vein between two ligatures, the resulting œdema and trouble were much less than I expected; in one case they could scarcely be said to occur at all. But this result is not to be relied upon. It probably depends on the level at which the venæ comites of the brachial join the basilic (a somewhat variable point), and the relation of this to the part tied. As there is a most distinct risk of a heavy œdematous arm resulting, the only excuse for resecting part of the vein is when an enlarged gland is adherent to it and breaks down in the attempt to remove it. Whether it is needful to expose and clean the artery is doubtful; Dr. Halsted (*vide infra*) thinks it safer to do so. It prolongs the operation considerably. Mr. Watson Cheyne practises a careful step at this stage which is noteworthy. When the vein has been cleaned and the axilla cleared out there still remain some lymphatics which run up behind the vessels towards the posterior triangle. These may be infected. To remove them "the vessels and nerves must be lifted up, and this mass of fat and glands lying in the triangular space between the vessels in front, the scapula outside, and the chest wall inside should be taken away."

The axillary vessels having been defined and cleaned, the surgeon will now be more at ease in stripping out the contents of the axilla from its inner and posterior walls. The fatty fascia which ties the mass of breast, &c., to these regions is further put on the stretch and dissected off from the serratus magnus and intercostals. As to the intercosto-humeral nerve, it is not worth while to dissect it out and preserve it. The lateral branches of the intercostal vessels need careful cleaning and securing, especially below at the juncture of the internal and posterior wall, where, in the thickest part of the serratus magnus, there is always an anastomosis between the above-mentioned vessels and the subscapular artery. This anastomosis will certainly be cut into if the fat and fascia over the serratus magnus have been efficiently removed. Unless these bleeding points are promptly secured, much blood will be lost, and a collection of blood may easily take place here, and cause trouble afterwards.* As the posterior wall is cleaned the subscapular vessels and nerves will come into view. It is very easy, by using undue force or haste in stripping clean the subscapular or other veins, to tear one or more of these away close to the parent trunk, sometimes leaving a small hole punched out in this vessel. In such cases the hæmorrhage is most embarrassing, and must be met either by taking up the aperture with a purse-string suture of fine sterilised silk, or ligaturing the vein above and below—a point alluded to above.† If there be time, if the patient's condition be favourable, and if the fat strip easily away, the subscapular nerves, especially the long one, should always be spared. Under other conditions no time should be spent in dissecting them out. As will be seen below (p. 677), Dr. Halsted is not yet decided on this point. Mr. Butlin (*Operative Surgery of Malignant Disease*, p. 397) writes: "I have not attempted to spare the subscapular nerves, and I have been surprised to find that the movement of the upper extremity is remarkably good, provided too large an area of integument has not been taken away." For my own part I consider that loss of power in the latissimus dorsi should not weigh for a moment against any step that favours complete removal of the disease; that if primary closure of the axilla and primary union of the axillary end of the wound be secured—conditions which are always possible—and the precautions given below as to the position of the limb and early movement be followed, a very useful arm and shoulder-joint will result. Fig. 232 shows how much elevation and abduction may be gained three weeks after the operation, even where both pectorals have been removed on each side, if the after-treatment is attended to.

The posterior wall of the axilla having been now cleaned to a point on a level with the latissimus dorsi, all that remains is to sever the mass of breast, &c., along the line of its connection with the outer border of this muscle.

The operator now scrutinises the wound to see what scraps and tags of fatty tissue may remain in dangerous positions—*e.g.*, over the subscapularis, or along the vessels, or in the apex of the axilla. In spite of the greatest care to get the diseased structures away in one piece, such shreds of tissue may be left. At this stage the huge wound, which has been kept carefully covered, wherever possible, with dry sterilised gauze, should show a floor consisting, from within outwards, of muscle—*e.g.*, above, clavicular part of pectoralis major; a little lower, a narrow rim of costo-sternal portion of the same muscle, external intercostals, upper part of external oblique, attachments of pectoralis minor, serratus magnus, subscapularis, teres major, and latissimus dorsi in part. Bleeding is next finally attended to. Throughout the operation, in order to diminish the shock inseparable from these extensive and prolonged proceedings, great care must be taken to secure every bleeding point, and to tie off the forceps before they accumulate, instead of trusting to their being moved out of the operator's way as required, a course which often leads to their becoming entangled with each other. But at this stage there is another reason for rendering the wound as dry and bloodless as possible. Primary union depends largely on absence of any after-oozing and tension on the sutures, which are very likely to be themselves taxed to the utmost. Two difficulties arise here. One, that, owing to a depressed state of the circulation, vessels may not bleed though unsecured. The administration of a little ether is safe on other grounds; or gentle friction of the wound, as advised by Mr. Sheild, may be of assistance here. If these fail, and the operator is rendered anxious by the unnatural absence of bleeding, he should insert a drainage-tube (p. 671) and apply his bandages with additional firmness. The other difficulty is of a different kind. The perforating branches of the internal mammary, when they are cut short and retract, may give much trouble. I have been able to meet this either by the use of Spencer Wells's forceps curved on the flat, and ligature, or by pressure. But the following case of Mr. Sheild's (*Diseases of the Breast*, p. 402) shows how embarrassing this difficulty may be, and how it may be successfully met. Met it must be, otherwise the persistent bleeding will lead to tension and separation of the flaps.

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* Thus, such a collection will lead to tension on the flaps; it will probably require opening and draining. Lastly, from the proximity of the axilla, which with its re-growing hairs it is not always easy to keep sterile, such a collection may suppurate.

† The remarks made above on injury to the vein apply, of course, with increased significance, to the artery. Mr. Sheild says that he has seen similar trouble to that described above occur by cutting arterial branches when pulled on, close to the main trunk. He has twice seen lives in great peril from the step that was found needful, viz., ligature of the main trunk above and below the opening.

> "A perforating vessel, the size of a small quill, was cut or torn, flush with the thin structures in the fourth interspace, about two inches from the sternum. It retracted and bled profusely and persistently. All methods of securing it failed, and a fine curved needle threaded with silk was dipped into the tissues around; but all to no purpose. A hare-lip pin was passed through the lower flap, and a small piece of sponge the size of a walnut was threaded upon it, and then the pin was passed through the other flap; a figure-of-eight silk suture being applied. All bleeding was arrested. The pin was removed on the third day, and the sponge on the fourth. The case did well."

Mr. Sheild (*loc. supra cit.*, p. 403) also alludes to another and much rarer difficulty, that of calcareous arteries, which persistently broke off when the ligatures were tightened. This was successfully met by leaving on pressure-forceps for twenty-four hours.

Two questions now arise. If the operator is, before closing his wound, inclined to *irrigation*, I strongly advise him to use only boiled water. If proper aseptic precautions have been taken throughout, irrigation is not required. Certainly, with so large a surface exposed, no kind of chemical solution should be employed, except, perhaps, where a septic condition has been present, such as an ulcerating carcinoma (p. 651); and the same reasoning applies to the use of iodoform.

The question of *drainage* next presents itself. Where the axilla and the cavity of the wound are very deep, where any oozing continues—and sometimes, owing to the condition of the patient, the operator is hurried at this stage,—where the flaps are loaded with coarse unhealthy fat, and, I may add without offence, in his earlier operations, the operator will do well to use a large india-rubber tube, sterilised by efficient boiling, with one end projecting from the axillary end of the wound, and the other brought out posteriorly by a counter-puncture.

It remains to close the wound. Three courses are open here. (i.) A method which will suffice in a large proportion of cases, even where the wound measures upwards of eleven inches in length by seven or eight in breadth, if elliptical incisions have been employed, is that of *undermining* and the use of *stout silver wire*. The bases of the flaps must be first freely undermined in every direction, upwards almost to the clavicle, inwards over the sternum, downwards over the external oblique and lateral thoracic wall. Care must be taken to cut the flaps as thick as possible, and with even incisions of uniform depth, the blade being used on the flat. Three or four sutures of stout silver wire* are then passed through the flaps a full inch from their edges.† To the ends of the wires Spencer Wells's forceps are clamped, and the flaps then slowly and steadily approximated. To effect this the wire *must* be stout, it must have an efficient hold on the flaps, and these, owing to the resulting tension, must be slowly and deliberately dragged together. Large needles will be required. No special apparatus, such as leaden buttons, is necessary. The flaps need not meet exactly, as the next step will accomplish this. Numerous (twenty or more) stout salmon-gut sutures are next introduced, clamped, and tied off in batches, the surgeon working at one end, and an assistant at the other. While this is being done, another assistant with sterilised pads renders the wound dry by careful pressure on the flaps. By the very numerous salmon-gut sutures the tension is evenly distributed over a long line. Not unfrequently it will be found possible, when all the sutures are tied, to cut those of silver, thus relieving the chief tension. Dossils of sterilised gauze are now wrapped round the silver wire to prevent their ends pricking the patient. A strip of sterilised green protective is then applied, and large sterilised pads, this dressing being kept in position by even bandaging; the object being to distribute the oozing as uniformly as possible, and to meet its tendency to come through at three spots—viz., at the lower border of the dressings, at the sternal end of the wound, and behind the axilla.

It is well, before the elbow is shut in, to dust a little boracic acid powder over the fold in front, especially when the patient is one inclined to intertrigo, and when the weather is hot, owing to the irritation of the perspiration thus retained.

(ii.) *Transplantation of Skin Flaps.*—Mr. Butlin and Mr. Adams, at a meeting of the Medico-Chirurgical Society, April 1896, recommended this step in cases where primary closure of the wound could not be otherwise attained. The method of transplantation by rotation was recommended. The flaps should have large bases and should not be more than three and a half or four inches long. To this method there is one objection, and one of much weight. The patients, after an extensive operation such as that of to-day for removal of the breast, are not in a condition to stand the additional time and anæsthetic required for the careful making and transplantation of flaps. Where primary closure of the wound cannot be attained by undermining and dragging the flaps together, it will be wiser to resort to the next method.

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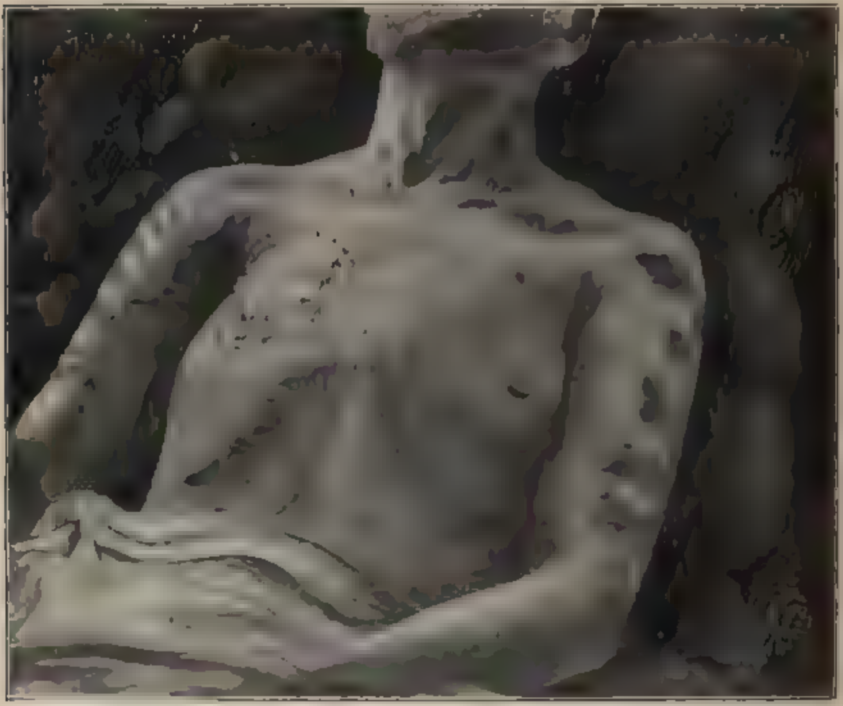
* Silver wire is necessary. Stout silk, however efficiently boiled, cannot be relied upon to remain sterile if points of stitch-necrosis take place.

† Before these are inserted the surgeon carefully adjusts and regulates the line along which the flaps will be approximated, bringing the lower one from without inwards. Tension will be felt least at the axillary and most at the sternal end of the wound.

FIG. 228.



To illustrate the results of Thiersch's grafting. The patient—one of Dr. Scott's, of Ealing—was under my care in March 1900. The photograph was taken ten days after the grafting. On the arms are the scars left by the grafts.

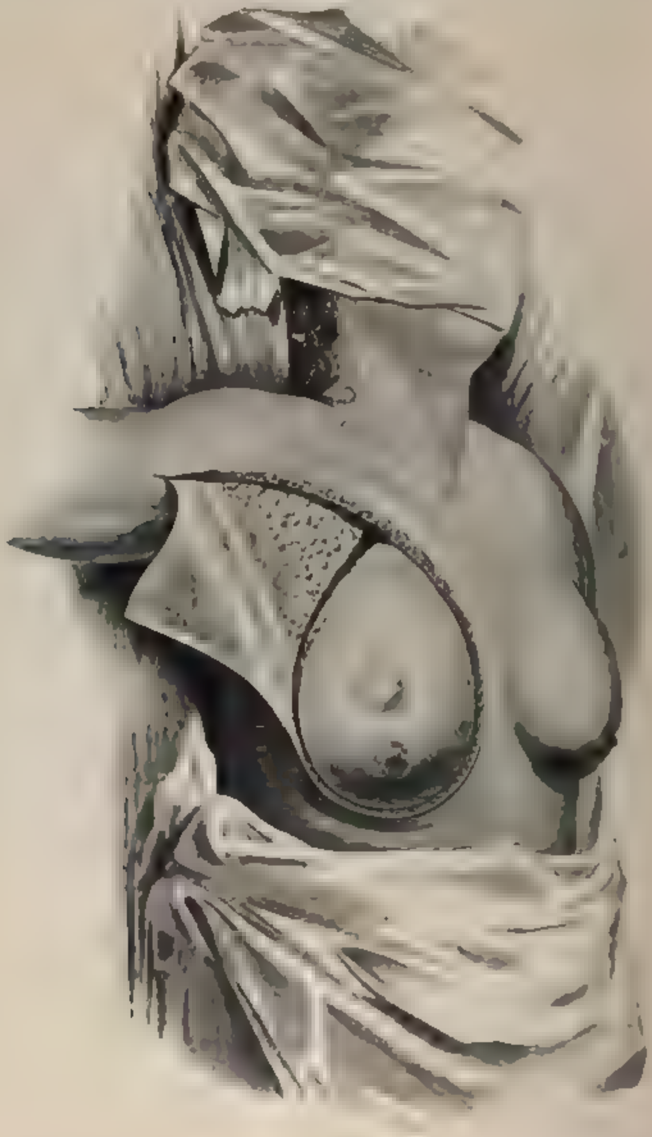
(iii.) *Skin-grafting by Thiersch's Method.*—While this may be employed at the time of the operation in a wound which cannot be completely closed, it is best to defer it to a date between the eighth and fourteenth day. Though this involves a second anæsthetic, the patient will be in a much better condition; the surface of the wound will be smaller, and a level, uniform one, and there will be no oozing. This method of skin-grafting has been fully described at p. 188.

After-treatment.—The patient should be kept on the sound side for the first few hours after the operation, as this promotes the escape of any vomit well away from the dressings, while it also helps to prevent any collection of fluid at the axillary end, where the chief cavity has been made. Afterwards the patient should be kept, supported, up in the bed as much as possible, to prevent that tendency to stasis and broncho-pneumonia which is so close at hand in the subjects of chronic bronchitis, obesity, &c. If possible, after the fourth day the patient should be lifted into an arm-chair and spend an hour or two out of bed daily. These patients are not only kept too long in bed, but the arm is usually kept closely to the side too long. For the first few hours, to check any oozing, and to meet any restlessness after the anæsthetic, the arm and forearm must be kept securely quiet. But after this the arm should be gently and easily abducted by a large pad of salicylic wool in the axilla. A little later the patient, while in bed, should be encouraged to keep the limb away from her side with the forearm extended, while at night a sling should again be resorted to. The degree of abduction should be gently increased day by day, while by night the limb may be now kept abducted, but steadied by a splint. In about ten or fourteen days more active outward and upward movements should be practised. While after-limitation of movement is partly unavoidable owing to the necessary free removal of skin, &c., much of the after-stiffness will be prevented if care be taken at the time of the operation to secure primary closure of the axillary end of the wound without much tension, and if, later on, both surgeon and patient will dispense with the too usual rigid bandaging of the arm to the side, and be more persistent in practising early movement.

With regard to the dressing of the wound, the first dressings will probably require to be additionally packed, especially behind, during the first forty-eight hours. And the patient, whatever position she take, should always lie on thick gauze pads during the first three or four days, lest any discharge come through, especially when she is left undisturbed to sleep, and reach the sheets. If a drainage-tube has been employed the wound should be dressed on the second day, the tube removed, any over-tight sutures cut, and the dressings left undisturbed for another four or six days. If no drainage-tube has been employed, the need of dressing will generally turn upon the tension of the sutures. As the skin, owing to its elasticity, has great accommodating power, it will generally be found, if the tension has been distributed over a large number of sutures, that no stitch-necrosis, or very little, takes place, and that the dressings may be left undisturbed till the fourth day or later. Where much tension is probably present it will be well to change the dressings about the fourth day, even if the temperature be normal. Such a step adds much to the comfort of the patient, and two other objects are attained. One is the division of any sutures which are already causing, or are about to cause, slight ulceration. With regard to these, it is not necessary to disturb the edges of the wound by *removing* the sutures. Judicious *cutting* of those on which the tension is too great is all that is required at first. Further, too many must not be divided at this early date, or there will be gaping of the wound in the second week. The other advantage which I consider gained by dressing the wound about the fourth day, is that an opportunity is secured of cleansing the axilla. This step is rendered advisable by the difficulty of sterilising a region like this at the time of the operation, and the growth of hair which has taken place.

Halsted's Method.—Out of respect to Prof. Halsted and the excellent work which he has done in many directions at the Johns Hopkins University, Baltimore, I here quote, in his own words, the account of his mode of removal of the breast (*Ann. of Surgery*, Nov. 1894):

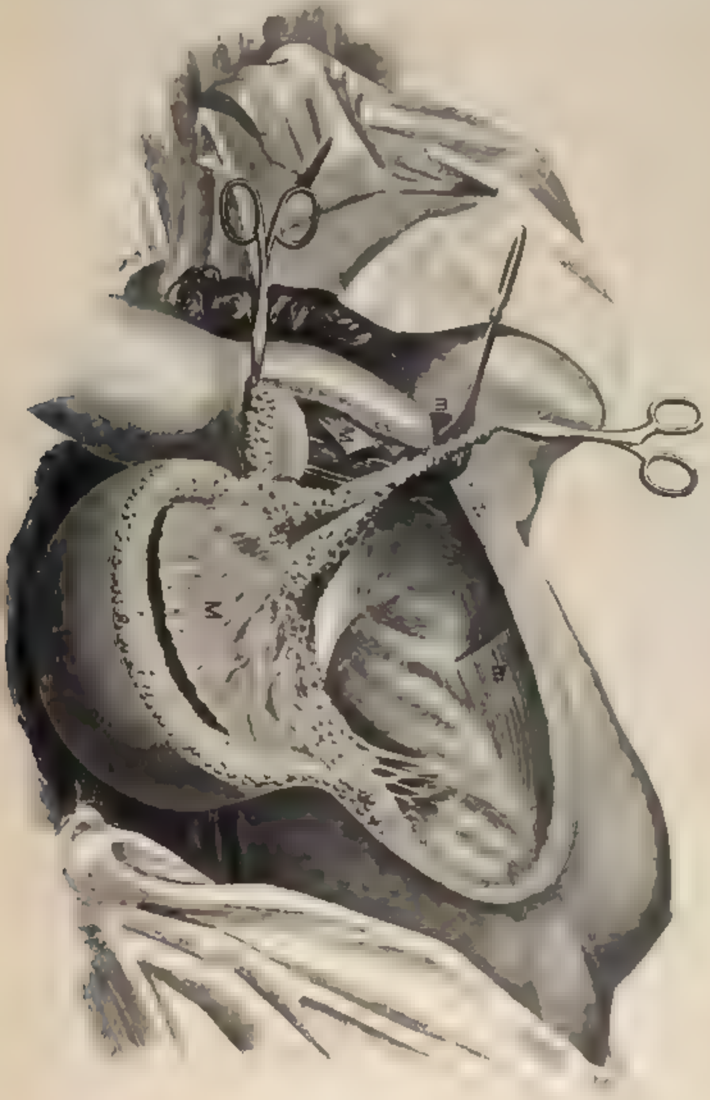
Fig. 229.



(Halsted.)

"(1) The skin incisions are carried at once and everywhere through the fat. (2) The triangular flap of skin (Fig. 229) is reflected to its base. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major, where it is continuous with the fat of the axilla. (3) The costal insertions of the pectoralis major (M, Fig. 230) are severed, and the splitting of the muscle, usually between its clavicular and costal portions, is begun and continued to a point about opposite to the scalenus tubercle on the clavicle.* (4) At this point the clavicular portion of the pectoralis

FIG. 230.



(Halsted.)

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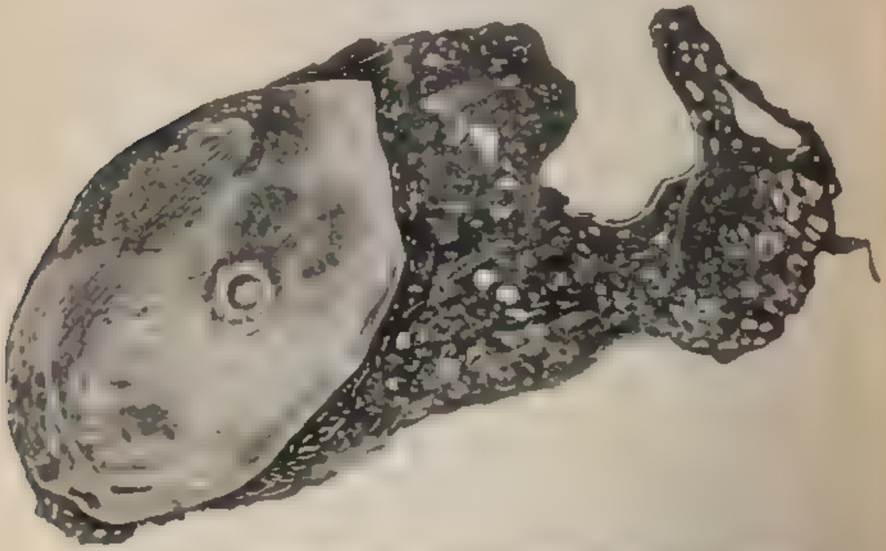
* (?) First rib.

major and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla. (5) The loose tissue under the clavicular portion (the portion usually left behind) of the pectoralis major is carefully dissected from this muscle as the latter is drawn upwards by a broad, sharp extractor. This tissue is rich in lymphatics, and is sometimes infiltrated with cancer. (6) The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment. (7) The whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin incision, is raised up with some force, to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor. It is well to include the actual sheath of the minor muscle when practicable. (8) The lower outer border of the minor muscle having been passed and clearly exposed, this muscle is divided at right angles to its fibres, and a little below its middle. (9) The tissue, more or less rich in lymphatics, and often cancerous over the minor muscle near its coracoid insertion, is divided as far out as possible, and then reflected inwardly to liberate or prepare for the reflection upwards of this part of the minor. (10) The upper, outer portion of the minor is drawn upwards (Fig. 230) with a broad, sharp retractor. This liberates the retractor, which until now has been holding back the clavicular portion of the pectoralis major. (11) The small blood-vessels (chiefly veins) under the minor muscl
insertion must be separated from the muscle with the
These are embedded in loose connective tissue which s
lymphatics, and contains more or less fat. This fat
with cancer. These blood-vessels should be disse

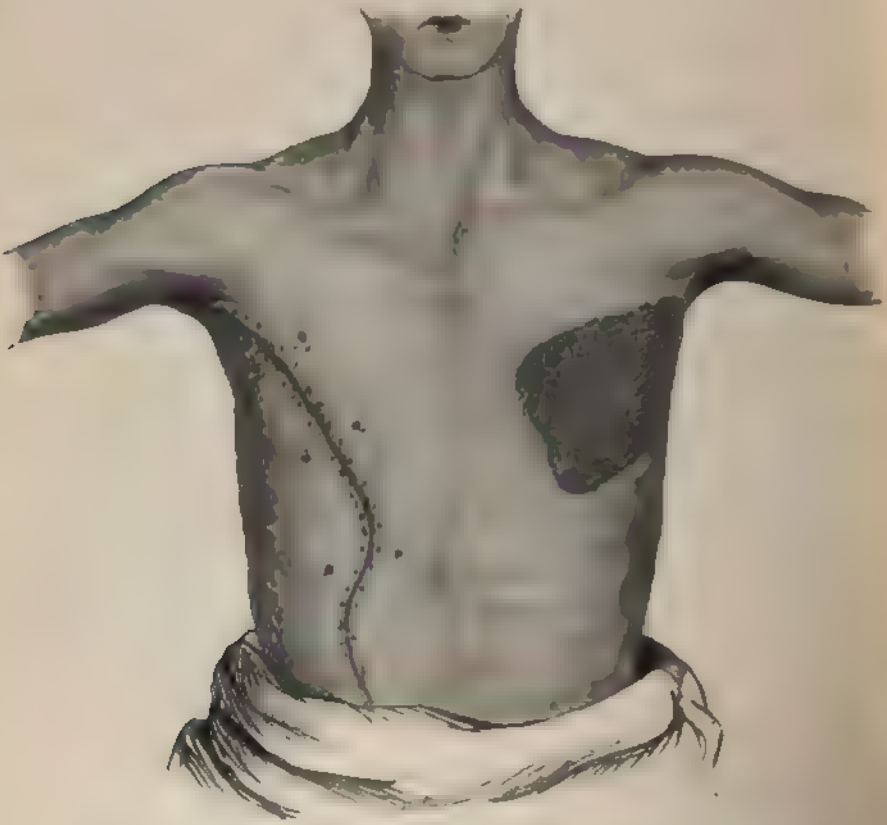
FIG. 231.



This shows the continuous whole or single piece, breast, axillary fat and glands, of which the part removed should consist (Halsted.)

and immediately ligated close to the axillary vein. The ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off, or the vessels themselves might be torn away by the clamps. Furthermore, the clamps, so many of them, if left on the veins, would be in the way of the operator. (12) Having exposed the subclavian vein at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers, as advised, I am sorry to say, in modern text-books, and as practised very often by operators. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed, it is best to push the vein away from the tissues rather than, holding the vein, to push the tissues away from it. It may not always be necessary to expose the artery, but I think that it is well to do this. For sometimes, not usually, the tissues above the large vessels are infiltrated, and we should not trust our eyes and fingers to decide this point. It is best to err on the safe side and to remove in all cases the loose tissue above the vessels and above the axillary plexus of nerves. (13) Having cleansed the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla. We must grasp the mass to be removed firmly with the left hand, and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus. (14) When we have reached the junction of the posterior and lateral walls of the axilla, an assistant takes hold of the triangular flap of skin and draws it outwards to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi. The operator, having taken a different hold of the tumour, cleans, from within outward, the posterior wall of the axilla. Proceeding in this way we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed, at the discretion of the operator. Küster lays great stress upon the importance of these nerves for the subsequent usefulness of the arm: we have not as yet decided this point to our entire satisfaction, but think they may be often spared to the patient with safety. (15) Having passed these nerves, the operator has only to turn the mass back in its normal position, and to sever its connection with the body of the patient by a stroke of the knife. All that has been removed is in one piece (Figs. 230 and 231). There are no small pieces or shreds of tissue. I believe that we should never cut through cancerous tissues when operating, if it is possible to avoid doing so. The wound might become infected with cancer, either by the knife which has passed through diseased tissue, and perhaps causing everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli, or from the lymphatics. The division of one lymphatic vessel and the [illegible] cell may be enough to start a new cancer. . . . [illegible] perform it, is literally an almost bloodless one. From the first to the last each bleeding point is stopped with an artery-forceps as quickly as possible. When practicable, the vessels are clamped before they are divided. . . . . The edges of the wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin, only the base is included in this suture.

FIG. 232.



E. S., æt. 54. The left breast had been removed at another London hospital in February 1899, the pectoralis major being left entire. Recurrence took place in the scar towards the end of the same year. Patient came under my care at Guy's Hospital with a scirrhus of the right breast, the existence of which had been known for three months. Both sides were operated upon, simultaneously by myself and Mr. C. T. Hilton, on December 10, 1900, both pectorals being removed on each side. On the right side I found it possible, by extensive undermining, to drag the flaps together—the three larger dots on each side showing where the stout silver wire used had caused slight tissue-necrosis. On the left side the above step was impossible. The photograph was taken on January 3, 1901, and Thiersch's grafting was resorted to, on the left side, on January 4. The amount of elevation which can be regained in three weeks after a double operation is also shown.

The rest of this flap is used as a lining for the fornix of the axilla. The apex of this flap is consequently shifted to a new and lower position. The axilla is never drained, and invariably heals by first intention.

The uncovered wound often heals by the so-called organisation of the blood-clot."

C. **Long-continued supervision repeated at first at short intervals.**—The patient should be kept under skilled supervision, and for the first few years an inspection of the scar should be made every three or four months. Any local recurrence in or near the scar should at once be attacked widely and deeply (p. 680), resection of one or more ribs being performed, if needful, as in the case to which I have alluded at p. 694.

There are still a few points of much importance to be discussed before the subject of removal of the breast for cancer can be said to have been dealt with. I refer to such points as—(i.) *The removal of both breasts.* (ii.) *The value of palliative operations.* (iii.) *Operations for recurrent cancer.* (iv.) *The advisability of performing such operations as amputation at the shoulder-joint, or Berger's amputation.* (v.) *Oophorectomy for inoperable cancer of the breast.*

(i.) *Removal of Both Breasts.*—It occasionally, though rarely, happens that, as in the case shown in Fig. 232, a patient comes for advice with cancer of both breasts. By some, operation at this stage has been condemned on two grounds—viz., its certain futility and its additional severity. In my opinion, no such rule can be laid down. Each case must be considered by itself. The following are the chief points which will guide in a decision. First and foremost, the surgeon must decide whether the growth is a primary one on both sides, or whether on one side it is secondary to the other. In the latter case the disease is so widespread that operation is not to be recommended. In the former, if there be no evidence of visceral or secondary deposits (beyond any in the axillæ), operation may be recommended if the patient's age and vitality be favourable. And here age is a point of much importance. If the patient be young, the presence of bilateral disease is probably a sign of the mischief being widespread, and operation will be useless.

When operation has been decided upon, the question will arise as to whether the breasts should be removed simultaneously or no. If possible, the two breasts should be removed at one operation. And as the operation of the present day is so extensive and requires such prolonged care, it will be best if the operation is done simultaneously by different operators. Such a step much diminishes the risk and also the discomforts of the patient, especially that of the anæsthetic, while, where the vitality is good, the shock is not dangerously increased. Extra care in nursing will diminish the additional trouble entailed by the needful restraint of both arms. But no fixed rule can be laid down here. Where the vitality is poor, where there is any bronchitis, where the breasts are large and the wounds necessarily extensive, it may be well to postpone the second operation for two or three weeks. Where it is clear that the operation on one side will be so extensive as to call for Thiersch's grafting, this may indicate the advisability of removing the breasts by two operations. In the case shown in Fig. 232, both breasts were removed simultaneously; and this figure illustrates two other points in these cases—one, that w [illegible] are removed on the wide lines of the present [illegible] ely or no, it will probably be impossible to [illegible] wounds; and it further proves how earl [illegible] attention is given to this point (ii.) *The Value of Palliative Operations.*—Patients occasionally come to the surgeon asking for operation, under conditions which make it certain that any benefit given by surgical interference will be only temporary. The following may be among the reasons that arise for consideration: (*a*) Relief from pain, which otherwise increases daily; the misery of waking every day to the consciousness of an incurable disease; the sometimes loathsomeness; the restlessness for cure (Paget). (*b*) Death by deposits in the viscera, these being unseen, is less distressing to the patient than death by the original cancer in the breast, which is always under her eyes. (*c*) The patient may have special reasons for wishing to live and get about in comparative comfort for a year or so.

Thus, in a case mentioned by Sir B. Brodie (*Lect. on Path. and Surg.*, p. 202), he declined at first to operate on a lady with a scirrhus of the breast on the point of ulcerating. In a few weeks the patient returned, begging to have the breast removed, that, her life being rendered more comfortable and active, she might accompany in society an only daughter. The operation was successfully performed, and at the end of two years the patient died of secondary pleuritic effusion.

No general rule can be laid down here. Each case must be decided on its own merits. But the following cautions may not be superfluous. Especial care should be taken in these cases to exclude, as far as possible, the presence of metastatic deposits. If these are certainly present no operation should be performed. The patient's general condition and vitality must be sufficiently good. There must be grounds for honestly supposing that the local disease which it is proposed to attack will be got away; otherwise the latter condition of the patient may be rendered worse than the first. Again, in these palliative operations it should be clearly explained to the patient and her friends that the operation will only be palliative. Some patients, and especially the friends of some patients, are only too ready, when it becomes evident that no cure is possible, to forget the plain and honest warning that was given, and to place the entire responsibility on the surgeon. And this leads up to one more point. In these palliative operations, and in all doubtful operations for cancer, it is not only the individual patient that has to be considered; the thoughtful surgeon will remember the effect of his operation on many other potential patients. Thus, a palliative operation or an extensive operation under conditions doubtful of success is performed, both sides of the question having been honestly put before the patient. The operation is not permanently successful, as was fully explained might be the case. The want of permanent success is known to a circle of varying extent. We do not sufficiently consider what effect this want of success has on other patients also sufferers from cancer of the bosom—but quite ignorant of the conditions in which the operation referred to was performed—in leading them to conceal their cancer, at the time eminently suited to operation, until the most favourable opportunity has passed away.

(iii.) *Operative Treatment of Recurrent Disease.*—A very poor prospect of success is offered here, chiefly because the disease proves to be far more extensive than appears to be the case. This is especially true of recurrence in the axilla. Such conditions as extensive infiltration of the skin, either by shotty nodules or by the evidence of *peau d'orange*;*

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* Much to be preferred to our coarser English expression, "pig-skin."

infiltration of the glands in the neck, evidence of visceral deposits, implication of the axillary vessels and nerves, prohibit operation absolutely. In my opinion, the only conditions which justify hopefulness in dealing with local recurrence are (1) small local nodules in the scar or the axilla, or (2) infected areas of larger extent occurring in cases where the operation performed has been a limited one, and not on the wide lines which have been recommended above. And the chief points which guide me are the degree of mobility and the size of the recurrent mass. But even where these and other points appear favourable, the real extent of the disease, the facts that the operation has now to be performed in scar tissue and not in loose fat, and that the anatomical landmarks are much altered, militate greatly against success. Local recurrence after the improved operations of to-day is much rarer, but it does occur, and the fact that in these cases the preceding operation has been on wide lines shows, I think, that here the disease from the first has had an extensive hold on the patient. I will conclude with one or two hints. If the recurrence, though local, is deeply seated in the tissues of the scar, necessarily scanty after removal of the pectorals, I believe the only operation likely to be useful is partial resection of the ribs, as in my case alluded to at p. 694. If the recurrence is in the axilla the exploratory incision should be of the freest, as these are just the cases where the axillary vein may be easily opened.

Finally, we must all allow that the only real treatment of recurrent disease is preventive. It is only by operating, *on the first occasion*, on the widest possible lines, and in the most thorough manner, that we can really meet recurrent disease. In Mr. Watson Cheyne's weighty words, "the patient's chance lies in the first operation."

(iv.) *Removal of the Entire Upper Extremity or Amputation at the Shoulder-joint for Recurrent Inoperable Carcinoma.*—These operations have been occasionally performed with the object of giving relief to the agonising pain and heavy, œdematous, swollen, immobile state of the limb which sometimes is seen to follow implication of the axillary vessels and nerves. Any hope of cure, even by the most extensive of these operations, is quite out of the question. Decided relief will be given, but it will not be unmixed relief. Some sixteen years ago I amputated at the shoulder-joint in a case of this kind. Great relief to the pain was given, but it was clear to me that during the five months which preceded the patient's death the loss of one hand was constantly present to her. If any such operation be performed, it should be on the lines of those of Berger (vol. i. p. 177), and not an amputation at the shoulder-joint, in which the incisions may pass dangerously near to the disease. Mr. Dent brought such a case before the Medico-Chirurgical Society (*Brit. Med. Journ.*, March 12, 1898).

Here the left breast had been removed (in a woman æt. 53), together with the affected axillary glands, in December 1894. In September 1896 a recurrent nodule was removed from near the scar. In October 1897 the patient was readmitted with a recurrent ulcerating growth high up in the axilla. The arm was much swollen and the pain severe. On October 22, 1897, the upper extremity, scapula, and outer two-thirds of the clavicle were removed by M. Berger's method, hæmorrhage did not exceed two or three ounces, and there was no shock. All the diseased parts appeared to have been removed. The patient made a rapid recovery, and great relief followed the operation. But in March 1898 there was evidence of secondary deposits in the liver, and the patient died on April 10, 1898.

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* Of these the chief was cutting the
involvement of the skin in the axilla.

This operation is, in my opinion, scarcely to be recommended.* It is palliative only, and the relief it gives is temporary and obtained only at great cost. Cases of recurrent cancer causing agonising pain from involvement of the brachial plexus are extremely rare. Swollen, heavy, œdematous limbs are more common, though also rare. In such cases relief can almost always be given by elevation of the limb at night, aided by careful bandaging or a well-fitting support always worn. Very rarely, owing to the patient's neglect, this condition of œdema has gone so far that recurrent attacks of erysipelas or sloughing are present. Amputation by Berger's method would now be justifiable, but both sides of the case must be clearly put before the patient. And, before performing such an operation, I should advise exploration to see if it were possible to remove the recurrent disease sufficiently from the axillary vessels and nerves to allow of the remainder of life being relieved from pain at a less cost than loss of one hand. Division of the brachial plexus high up in the neck, which Mr. Dent suggests might be considered in some of these cases, would, I fear, have to be carried so far as to render the limb useless. Mr. Dent is of opinion that the following would be favourable *indications* for the above operation :—(1) Previous removal of the breast, with dissection of all the lymphatic tissue and fascia off the pectoralis major, a step which lessens the likelihood of mediastinal infection. (2) Slow growth of the original tumour. (3) Slow growth of the recurrent disease. (4) Limitation of the recurrent growth, so that the incisions may be carried wide of the disease. (5) The certainty of relieving pain. "Unless the pain were severe, indeed the predominant symptom, the operation would hardly be taken into serious consideration." (6) The existence of a foul cancerous ulcer high up in the axilla. Mr. Dent gives the following as *contraindications* :—(1) The probability of leaving in the wound the cut surface of any part of the carcinoma, as leading to rapid increase and fungation of the growth. (2) The involvement of the thoracic wall. (3) The presence of an extensive degree of cancer *en cuirasse*. (4) The more obvious contraindications of cancerous deposits elsewhere.

Mr. Stanley Boyd, whose energy and skilfulness are well known, has also advocated high amputation in these cases (*Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1167). Two instances are given. In one amputation was performed below the tuberosities of the humerus, in January 1900. The patient could get about afterwards and do some work till three weeks before her death. Finally the stump ulcerated, death taking place in July 1900. In the other case, amputation was performed at the shoulder-joint in January 1900. After this the patient got about more easily. In April 1900 she died.

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* Sir W. M. Banks gives one successful case (*Clinical Notes*, p. 59). By dissecting the subclavian triangle and peeling off several enlarged glands from the nerve trunks, relief was given to the previous intolerable pain. Mr. Sheild (*Diseases of the Breast*, p. 410) has had an equally successful case. But, as a rule, the nerve trunks are in these too much embedded in the deposits to admit of any such "peeling."

(v.) *Oöphorectomy in Inoperable Cancer of the Breast.**—The life of this operation, as of several others in late years, appears to me likely to be a brief one. The cases are, I think, sufficiently numerous to justify the following conclusions. While the operation has in a certain number of instances produced a decidedly beneficial result, these cases have not been numerous; and in every such case the benefit has been temporary only. Thus Mr. Stanley Boyd, who has taken up the matter with much interest, in his last paper (*Brit. Med. Journ.*, 1900, vol. ii. p. 1161) has collected 54 cases and divided them into two groups—(*a*) those in which oöphorectomy seemed to produce a clear and decided effect, such as shrinking and disappearance, sometimes rapid and even temporarily complete, of all the recurrent growths in the skin and glands, with disappearance of pain and swelling; (*b*) those in which oöphorectomy had little or no effect. Of the 54 cases thus classified, Mr. Boyd finds that 19 (35 per cent.) were more or less markedly benefited, 34 were not benefited or only doubtfully so, and one died of exhaustion. As to the duration of the improvement, when present, Mr. Boyd considers that as far as the cases as yet available for drawing conclusions go, in the majority the cancer growths reappear or begin again to increase in six to twelve months. It is interesting to note "that, with one exception, all the patients who had certainly passed the menopause are included among the failures." And it must be remembered that this operation is one of those novelties in practice in which we are likely to hear of successes chiefly.† When we remember that oöphorectomy is not to be relied upon for checking the hæmorrhage and growth of uterine cancer, it is probable that little is to be expected from this operation here. And it must be remembered that, whatever temporary benefits the operation may confer, it is liable to produce certain unpleasant effects of its own. Finally, it is to be noted that, in two cases referred to by Mr. Boyd, oöphorectomy for inoperable cancer of the breast has been fatal, in one case from "exhaustion," in the other from "intestinal matting." While I consider that the benefits of oöphorectomy for inoperable cancer of the breast are too uncertain, and, when they do occur, of too brief duration to justify the operation, to those who may think differently I would urge—(1) that they explain the matter fully and honestly to their patient and her friends, and leave the decision in their hands; (2) if the operation be performed, every atom of ovarian tissue must be removed. As pointed out by Mr. Doran, the ovarian ligament is sometimes very short, and may contain ovarian tissue close to its uterine insertion.

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* Whatever be the fate of this operation, the credit of suggesting a trial of it, in May 1896, must always be given to Dr. Beatson, of Glasgow.

† In Mr. Stanley Boyd's paper allusion is made to several unsuccessful cases, of which he was unable to give the full notes. Mr. Bowreman Jessett (*Brit. Med. Journ.*, vol. ii. 1900, Oct. 20, p. 1191) states that he has tried oöphorectomy with the administration of thyroid extract in four or five cases of inoperable mammary cancer, but in none was there any improvement. In April 1900 a woman was sent to me for an opinion as to whether anything further could be done for recurrent cancer of the breast. The ovaries had been removed without any benefit. The patient in describing her case, in answer to the question as to the result of the oöphorectomy, said, "I could see the cancer growing day by day as I lay in bed after the removal of the ovaries."

In conclusion, Mr. Stanley Boyd's opinion as to the practical results of this operation should be quoted (*loc. supra cit.*): "I think that oöphorectomy should be offered in cases other than the very acute, in women over forty, with no visceral or bone lesions, in fair condition, and before the menopause. In extensive primary cases and recurrences it seems advisable to remove what is possible of the disease; but healing should be attained, lest the oöphorectomy fail in its object and malignant ulceration be started."

With regard to the relative influence of oöphorectomy and of thyroid extract in producing the atrophy which sometimes occurs, opinions differ. Thus Mr. Boyd (*loc. supra cit.*) writes: "When endeavouring to ascertain the result of one mode of treatment based upon highly theoretical considerations, it is surely unwise to combine it with another method resting on still more shadowy grounds. I have consequently never given thyroid until satisfied that the oöphorectomy was failing in its effect. Then I have given it, but without obvious benefit; on the contrary, it has sometimes seemed to have a damaging effect." On the other hand, Dr. Herman ("Four Cases of Recurrent Mammary Cancer treated by Oöphorectomy and Thyroid Extract," *Brit. Med. Journ.*, Oct. 20, 1900, p. 1167) observed that Mr. Boyd's table comprised 17 cases in which oöphorectomy seemed to have favourably influenced the course of cancer. Of these 12 had been given thyroid extract. There were 21 in which no benefit had followed, and only 5 of these had had thyroid. This looked as if the thyroid extract had something to do with the result.

Thomas's Method of Removal of Innocent Mammary Tumours.—As fibro-adenomata are far from uncommon, and as any scar on the breast is much deprecated by young women, this operation, which Dr. Gaillard Thomas, of New York, introduced in 1882, may be made use of when a patient especially deprecates a scar on the bosom itself. An incision is made exactly following the groove between the skin of the lower half of the breast and that of the chest. On reaching the muscles, the breast is dissected from them sufficiently to allow of its being turned upwards so as to expose its posterior aspect. A straight cut is then made through this over the tumour, and the latter removed. The gland is then replaced. Antiseptic precautions must be employed and adequate drainage provided. The scar is invisible save when a free incision has to be made—*e.g.*, for a fibro-adenoma high up in the breast; the ends of it then show.

Owing to the excellent results and very trivial ultimate disfigurement which the ordinary method of removing fibro-adenomata affords, that of Dr. Thomas will very rarely be called for. Further, as Mr. Sheild writes (*Diseases of the Breast*, p. 213): "While excellent in theory, this operation is not always easy in practice, and its adoption will a good deal depend upon the position and mobility of the tumour. I have performed the operation on two occasions. The first was simple, since the tumour was easily reached from below. In the second case the growth was unexpectedly adherent, and I experienced great difficulty in its removal and also in the checking of hæmorrhage. Both cases did well, and the resulting scar was hardly visible. The difficulties of the second case, however, would deter me from again performing the operation unless in very accessible and movable tumour."

CHAPTER II.

PARACENTESIS AND INCISION OF THE CHEST. RESECTION OF RIBS.

PARACENTESIS AND INCISION OF THE CHEST.

INDICATIONS for interference in pleuritic effusions. Before interfering operatively, the surgeon has two points to consider. I. **Whether fluid is present.** II. **Whether it is purulent or not.** Space will only allow of my dealing with the second of these points.

II. **Is the fluid purulent or not?** The importance of clearing up this point is manifest from the fact that if pus is present it is very rarely absorbed; it may burst into the lung, may burrow about, making its way externally, causing hectic, caries, and lardaceous disease.

A. Exploratory puncture (*vide supra*). A large hypodermic syringe and needle should be used, absolutely sterile, pervious, and the needle sufficiently long and not too flexible. The timely use of this may save a patient from being treated for weeks or longer for chronic pneumonia. A grooved needle should never be trusted to. It is readily plugged by a pellet of fat, and thick pus will not flow along it.

B. Presence of pyrexia and hectic. This is not always reliable. Fallacies: (*a*) They may be absent, or little marked, in empyema, especially in long-standing cases, the alteration of the pleura or the degree of tension preventing absorption. Occasionally the disease is latent for many months. (*b*) Well-marked pyrexia may be present in serous effusions; thus, in these, the evening temperature may reach 101°. In 1886 I tapped the chest of one of our students, under the care of Dr. Pye-Smith, whose temperature was 103°. The fluid was serous, and after the single aspiration a good recovery took place.

C. The aspect of the patient. The tint is often anæmic and earthy in long-standing empyema, and the finger-ends, especially in children, clubbed. "If a child be seen with general pallor and finger-clubbing, one ought to think of empyema rather than of the other causes of clubbing—viz., chronic bone disease, bronchiectasis, and congenital heart disease" (Barlow).

D. Age. Empyema is common in children* and young adults.

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* In children the pleura seems to have a tendency to form pus (Goodhart).

E. Rigors. These are often slight, irregular, and may occur only towards evening. In children they are often absent throughout.

F. Any preceding disease. Empyema is not unfrequently seen after pneumonia, scarlet fever, measles, childbirth, pyæmia, small-pox, and especially typhoid fever. The onset is most insidious and often overlooked. If a patient during convalescence seems to go back, loses his appetite, any embarrassment of the breathing must be at once looked for, and empyema suspected.

G. Œdema. This is often absent, though pus is present.

H. Other signs, especially in children, must be remembered—viz., unexplained and obstinate diarrhœa, emaciation, &c.

Treatment of Non-purulent Serous Effusions.—Question of operation. If medical treatment—*e.g.*, absorbents and diuretics, counter-irritation, dry nutritious diet, &c.—fail, two questions arise: (A) *What is the danger of leaving the fluid?* (B) *What is the risk of paracentesis?*

(A) *Danger of leaving the fluid.*

1. There is the risk of sudden death when a large, quiet effusion persists.*

Dr. Moxon showed that the effect of the effusion varied with the side affected. Thus an effusion into the right chest not only pushes the heart over to the left, but also compresses the right auricle, and so shuts off blood from the heart, thus tending to produce syncope from cardiac anæmia. Effusion on this side also tends to make lateral pressure on the inferior vena cava, which is the more readily bent over, as it has just passed through a rigid ring. Effusion into the left chest drives the heart over to the right. and, pressing on the left auricle, distends the right side of the heart, by impeding the passage of the blood into the left ventricle, and thus tends to bring about syncope from cardiac plethora. There is also a tendency for the right lung to become œdematous, owing to its being engorged with blood.

2. The lung may become more and more tied down by adhesions—*e.g.*, when much lymph has formed.

3. The sound lung may become engorged, especially if the patient is submitted to a chill.

4. There is the risk of slow pus-formation, especially in a patient much let down, where the effusion is secondary to some other disease, and where there is the history of a chill.

(B) *The risks of paracentesis.*

1. Shock. This is especially probable in delicate patients with a nervous dread of the operation. 2. Syncope. A special cause of this is perhaps alteration of the position of the heart and large vessels by removal of the supporting fluid. 3. Embolism from detachment of clots in the pulmonary veins. That this is a real risk is shown by a case of Sir B. Foster's in which clots dislodged from the right pulmonary veins caused embolism of both renal and iliac arteries, with a fatal result from albuminuria, suppression of urine, and gangrene. Both 2 and 3 may

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* I think it is Dr. Clifford Allbutt who records the case of a girl who had been brought to Addenbrooke's Hospital with a large, quiet, serous effusion. Having got out of the cart which had brought her, she was walking slowly across the green in front of the hospital, when, without a cry or a stagger, she was seen to fall dead.

perhaps be prevented by not drawing off all the fluid, and drawing it off slowly. 4. Œdema of the lung. This is an undoubted danger. Shortly after the tapping (the effusion being usually a large one), urgent dyspnœa comes on with frothy, serous expectoration rich in albumen. Death usually takes place in about twenty-four hours. Dr. Duffin's explanation of this is probably the correct one. The compressed lung, after the removal of a large effusion, corresponds to a limb after the use of Esmarch's bandage—*i.e.*, the vaso-motor nerves are paralysed: thus, when the lung expands, sudden stress is thrown on toneless vessels; hence the transudation of sero-albuminous fluid, equivalent to the oozing so common after removal of the bandage.

Indications for Paracentesis in Non-purulent Effusions.

1. Threatened failure of the heart's action, shown by the failing pulse, the extremities growing cold, &c. 2. In all cases, and at any date, when the fluid is so copious as to compress the opposite lung. The base of this should be carefully watched, and any expectoration noted. 3. In all cases where, with a large effusion, there have been one or more attacks of orthopnœa. Relief will be most emphatically called for when, with this history, the patient lives some distance off, when he is no longer young and the chest no longer yielding, or when the opposite lung is at all œdematous. 4. In all cases in which a pleuritic effusion, occupying half one pleural cavity, has existed three or four weeks, and shows no sign of progressive absorption.

Paracentesis for Serous Effusions.—The site of puncture. This is decided by: (1) Physical signs. (2) The result of the exploring needle. Common sites are: (*a*) The sixth space in front of the posterior axillary fold, a spot which has the advantage of being thinly covered, and where the ribs are well apart. (*b*) In the seventh, eighth, and ninth space behind, in the scapular line. The eighth space is here very frequently used.

The patient having been turned somewhat over on to his sound side, if he can bear this, and brought to the edge of the bed, or, if he must be raised, so supported that he can be readily lowered in case of faintness, the surgeon, having seen that the spot chosen for puncture is cleansed from any poultice débris, &c., and that his aspirator is thoroughly clean and in good working order, fixes his nail just above the lower rib, and, holding the needle so that it cannot penetrate too deeply, plunges it straight into the pleural cavity, and then brings it into connection with the vacuum. If the skin is very thick, and the needle slender, it is well just to make a puncture with a scalpel's point. In either case it is the skin wound which pains.

The following practical points should be remembered: (1) Not to catch the needle on a rib, a mistake which is easy when the ribs are close together. (2) To be sure and enter the chest cavity, a thickened pleura or false membranes sometimes interfering with this. (3) To avoid injury to the lung, by not plunging the needle in too deeply, or by guarding the point when it has entered. Usually the lung is at a considerable distance, but when the collection is a localised one this accident may easily take place. (4) The fluid should not be drawn off too quickly or completely; if successive vacua are required, the later exhaustions should not be too complete. The patient should always be warned against making any sudden movement or a deep inspiration. If the flow stops suddenly, it may be due to a kink in the tube, or to a pellet of lymph plugging the needle. The flow should always be stopped at once—(*a*) if the patient faints, this being due sometimes merely to the withdrawal of a large amount of fluid, sometimes to the consequent displacement of viscera; (*b*) if any blood suddenly appears in the fluid, this coming usually from the rupture of vascular adhesions, more rarely from a wound of the lung; (*c*) if an irritating cough is set up, this being due sometimes to the unfolding of a temporarily compressed lung.

When the needle is withdrawn, the puncture should be at once closed with collodion and iodoform.

If an anæsthetic is asked for, it may generally be safely given with attention to the precautions given below (p. 690). But, as a rule, the pain is so momentary that this is not needful. I have been disappointed with the results of injection of cocaine. With a nervous patient the spot may be numbed by freezing the skin with ethyl-chloride. A little stimulant should be given before and after the operation.

Incision of the Chest for Serous Effusions.—This is indicated in certain cases of long-standing effusion where paracentesis has been performed more than once, and has on each occasion been followed by rapid re-collection of the fluid. Several successful cases have been recorded, the most striking being two described by Dr. Samuel West (*Brit. Med. Journ.*, 1898, vol. i. p. 494), in which the fluid had been present for twelve and fifteen months respectively. The first case was quite cured; the second patient at the date of publication still had a sinus, but was otherwise in good health and able to earn his living.

EMPYEMA.

The frequency of this in children* has been already alluded to.

At this time of life the prognosis is good, as the lungs are more likely to be free from morbid changes. The formation of pus may be very rapid at this early stage of life, pus being present by the fourth, fifth, or seventh day. The importance of this is considerable. With pus, lymph is present also, and thus—(*a*) the pleura is soon altered, thickened, and less prone to heal; (*b*) the lung becomes tied down; (*c*) the drainage-tube is readily blocked; (*d*) this lymph leads to subdivision of the cavity, and so to difficulty of thorough drainage and obliteration. All this shows the necessity of early and free incision.

Another important point is, that pus in the pleural cavity is frequently localised and encysted in children. This is not uncommon in the middle third of the thorax, the pus being limited above by adhesions, and below by the fixing of the lower lobe to the chest wall. Thus, at this spot loud bronchial breathing and modified resonance may be present. Finally, in children small multiple collections are not uncommon.

The surgeon will very likely be asked the question, whether the pus need be withdrawn, and if it will not be gradually absorbed. The chances of this are extremely small, and the risks of leaving it very great. They are—(*a*) external perforation, leading to the unfavourable results of insufficient drainage, caries, and amyloid disease. The most likely sites are—in front, above and below the nipple; antero-laterally, in the fifth space, just outside the rib cartilages. (*b*) Lung perforation, leading to gangrene and hectic. (*c*) Tuberculosis, if the belief is correct that an old empyema, even if caseated and inspissated, is still infective. (*d*) The empyema may also burst into the œsophagus or pericardium. In other cases it has been known to track downwards behind the diaphragm and give rise to a lumbar, gluteal, or even a psoas abscess. In such cases pulsation of the swelling has been observed, synchronous either with respiration or with the heart-beat.

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* Out of forty-four and sixteen consecutive cases of pleuritic effusion at Great Ormond Street, Dr. Barlow found twenty-seven and fourteen to be purulent.

Treatment of Empyema.

A. **Simple Puncture with Aspirator or Fine Trocar.**—This is seldom curative. The liability of the cannula to become plugged, and, usually, the need of repetition, are serious objections. It is justifiable in a few conditions—(*a*) if the patient is very young or very timid; (*b*) if the collection is very small, or multiple; (*c*) in advanced phthisis or pyæmia; (*d*) as a temporary or palliative measure in malignant disease, or in old and feeble patients. Patients thus treated should be watched for some time. In a few cases preliminary aspiration is to be strongly recommended, namely, in large empyemata of the left side where the heart is displaced. By aspiration, twenty-four or forty-eight hours before the chest is opened, the danger of syncope (which may be fatal), arising from sudden displacement of viscera, may be averted.

B. **Sub-aqueous Drainage.**—This method, formerly much in use, is now rarely seen. One end of a long piece of india-rubber tubing is introduced, through a large cannula, into the chest, while the other end dips into some antiseptic solution. *Advantages:* (1) The method is simple and little painful. (2) The tube is usually well tolerated, and, if secured, follows the movements of the patient. (3) The drainage can be made gradual and adapted to the expansion of the lung. (4) It is readily converted into a syphon for washing out the chest. I look upon this last as of very doubtful advantage, believing that, if the pus is fœtid, a free opening should be made at once, and that washing out the chest is always risky, and meddlesome and uncalled for when the pus is sweet. The *disadvantages* are—(1) The tube, necessarily small, is easily blocked. (2) Ulceration soon takes place around the tube, and thus air enters, or the tube slips out. It is allowable in children, or in very nervous patients, where the collection is neither great nor of long standing, and the lung will therefore be able to expand gradually.

C. **Incision.**—This, with very few exceptions, is the best method. Its chief advantages are the free drainage which it gives, and the facilities for washing out the pleural cavity (if this is required, *vide infra*). Although the method of simple incision has met with considerable success, yet in most cases nowadays a piece of rib is resected as well.

The chief *advantages* of this are as follows:—(1) Perfectly free drainage is provided for, since the largest size drainage-tube can be used, and there is no longer the fear of compression of the tube by closely placed ribs. (2) The aperture is large enough to allow the surgeon to thoroughly explore the cavity with his finger. Its extent and the characters of its walls may thus be gauged, and further valuable information at times obtained—*e.g.*, a case of pyæmia under Sir W. Savory, in which a distended pericardium was felt through an opening in the left pleura. This was opened through the same wound, and twenty-four ounces of pus evacuated (*Path. Soc. Trans.*, 1884). (3) The large masses of lymph so often found lining the cavity can be easily removed by the finger and a scoop, and prolonged discharge perhaps thereby prevented.

The *disadvantages* are, that the operation is more prolonged, and also somewhat more difficult, than simple incision.

There are practically no disadvantages as regards the effect on the rib itself, for new bone formation is generally quite rapid enough, and caries and necrosis are almost unknown. Removal of a piece of rib is then to be recommended, except where the necessary appliances are not to hand, or the condition of the patient forbids any but the shortest possible operation.

The question will often arise whether a single or a double opening is required. *A single opening* is usually sufficient in children and in young adults, owing to the healthy condition of the parts, and the natural tendency to obliteration of the cavity. The sites usually chosen are the eighth or ninth space in the scapular line, or in the same spaces anterior to and below the scapular angle. I prefer the latter in adults, as the chief part of the opening is anterior to the latissimus dorsi, an incision through this muscle, in adults, having certainly the risk of causing oozing afterwards, which may be very serious in a weakly patient. Hutton (*Brit. Med. Journ.*, vol. ii. 1898, p. 1321) recommends incision over the sixth rib in the mid-axillary line, because (1) this is the last point to which the lung expands; and (2) it is more comfortable to the patient. *A double opening* is very occasionally required—*e.g.*, in very large cavities in adults, when the pus is fœtid; when the case is of very long standing; when the pus is pointing high up and anteriorly, and thus the drainage is inadequate. The best instrument to cut upon in making the counter-operation is a stout silver probe. To this a drainage-tube can be attached by silk, and easily drawn into place.

The chief points of importance in the operation are the following: Amongst the first will arise the question of giving an anæsthetic. Speaking from an experience of thirty-eight cases, in thirty-four of which an anæsthetic was given, I believe that an anæsthetic may be safely given in the vast majority of cases. On the whole, I think that chloroform is the most suitable, on account of the greater struggling (undesirable with viscera displaced), the dyspnœa set up by the mucus, and the bronchitis subsequent to the administration of ether; but I am certain that the way in which the anæsthetic is given is of more importance than the anæsthetic itself.

Of the thirty-four cases alluded to above, I have only known bad results follow the anæsthetic once—a case of large empyema with pyopneumothorax. The heart was displaced to the right side, the face and lips somewhat cyanotic, the extremities cold, and the pulse almost imperceptible. Although the dangers of an anæsthetic were put before him, the patient insisted on having one administered. On the whole, I thought ether the safest, because of the condition of the pulse. It was administered carefully, but caused coughing. The pus was thus sucked into a bronchus, up into the trachea, and thence drawn down to the opposite lung, causing death rapidly. Artificial respiration expelled, during expiration, pus from the trachea. As this patient was almost moribund before the operation, I now much regret the giving of an anæsthetic. It would doubtless have been wiser to have refused one, and to have trusted to minimising the shock by exhibiting a stimulant and by a rapid operation.

A year later I was asked by my old friend, Dr. Goodhart, to operate on a somewhat similar case. This patient was also young, and there was here, too, a communication with the lung, the pus being, in this case also, fœtid, but the pulse was good and there was no cyanosis. Chloroform being given, the empyema was incised by Dr. Nicholson, now of Gainsborough, then clinical assistant, under my supervision. The anæsthetic in this case was taken well, the discharge quickly became sweet with iodoform dressings frequently renewed, and the patient made a rapid recovery.

The injection of cocaine, or freezing with chloride of ethyl, may be used where a general anæsthetic is thought inadvisable. While an anæsthetic is only really necessary where two openings have to be made, or where a rib is to be resected, yet its administration in capable hands is usually so safe that I always make use of it. When no rib is removed the operation is performed as follows:—

The patient being supported over the edge of the bed or table, partly rolled over on to the sound side, or, if this is impracticable, suitably propped up, the surgeon, having cleansed the part, fixes a finger-nail just on the upper margin of the lower rib in the space chosen, and makes an incision down to the muscles for 1½ to 2 inches, just above his nail. This incision having exposed the muscles, a steel director is driven through into the chest wall, care being taken not to plunge it too deeply.* A pair of dressing-forceps is then run along the director and opened widely both horizontally and vertically. Owing to the gush of pus which is now violently expelled, it is well to throw a piece of lint, out of carbolic solution (1 in 20), over the wound, while the pus is escaping.† The opening is next thoroughly dilated by means of a pair of lithotomy-forceps or sequestrum-forceps, the jaws of which are carefully separated, and the size of the cavity, the proximity of the lung, and the degree of granulation formation all investigated.

When, as will usually be the case, a portion of a rib is to be removed, the steps of the operation are slightly different. The incision is made directly over the rib and directly down to bone, the periosteum being divided. The periosteum is now stripped off the rib for a distance of about one inch and a half, with a slightly curved raspatory, care being taken to thoroughly clear the pleural surface. The rib is then divided in front and behind. This can in most cases be accomplished with a strong bone-forceps, but if the ribs are large and dense it may be necessary to first cut a groove with a saw.

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* If the chest is being opened low down, and the above warning not remembered, the director, or the dressing-forceps which follows it, may easily be sent into the peritoneal cavity.

† Occasionally, if the patient struggles, air is drawn into the pleural cavity after the escape of the pus, and then is expelled into the connective tissue of the wound, constituting emphysema. This will all pass off spontaneously. I have very recently met with a case of much more marked emphysema under the following conditions: Having been asked by my colleague, Dr. Pitt, to incise the chest of a child who, after lobar pneumonia of the right lung, had rapidly developed empyema on the same side, I noticed that, after an incision at the angle of the scapula, the usual violent outgush of pus—itself free from blood—was immediately followed by frothy blood and a markedly emphysematous condition of the wound. I believe that here the lung tissue, damaged by previous inflammation, had given way when the pressure of the fluid upon it was removed. A few days later it was evident that the lung had become adherent around the incision, which communicated freely with an opening in it, and that the emphysema had subsided. The case did well.

The piece of rib is now removed, and the cavity opened with director and dressing-forceps, as above described, care being taken to push in the director opposite the middle or upper border of the rib, in order to avoid the intercostal vessels. Having in this way made a free opening, and the pus having been evacuated, any large flakes of lymph may be removed by the surgeon's finger or a blunt-edged scoop, and a drainage-tube inserted. This should be of large size, and just sufficiently long to reach the cavity without projecting into it. The tube can be securely fixed in position by means of two fishing-gut sutures passed one on either side through the tube and then through the skin. When these are cut, a few days later, sufficient contraction will have taken place to keep the tube in position. A long safety-pin should, however, be passed transversely through the extremity of the tube, in order to prevent it from slipping into the pleural cavity. Hutton (*loc. supra cit.*) has recently described a drainage-tube fitted with a duck-bill valve, which, while allowing the exit of pus during expiration, prevents the entrance of air during inspiration, thus promoting a more rapid expansion of the lung. The advantages claimed are :—

(1) That it hastens materially the expansion of the lung.

(2) That it is simple, inexpensive, and comfortable.

(3) That by hastening the expansion of the lung it will obviate, in many cases, the necessity of Estländer's operation, which means the deprivation of the use of one lung.

(4) It is devoid of risk, as it only aids nature, by enabling the lung to keep the advantage it has gained by each expiratory effort.

Judging from the above points, and from the satisfactory results which Mr. Hutton describes, this apparatus is worthy of more extended trial.

Hæmorrhage during the operation is usually slight, and gives no anxiety afterwards. If any point give trouble, resisting ligature, after picking up the tissues with Spencer Wells's forceps, a pair of these left on for twelve hours will meet the case ; a bit of a rib quickly resected will give access to a wounded intercostal artery. The importance of not cutting through a thick muscle like the latissimus dorsi has already been alluded to (p. 690).

The opening must be sufficient, and, if there is any doubt about this, a further portion of rib should be resected without hesitation, especially where these are very close together, or where the pus is foul (*vide infra*, p. 694).

If the question of washing out the cavity arise, probably from the discharge being foul, it should be remembered that this proceeding, however gently done, has occasionally brought about grave and even fatal results very suddenly. Whether these have been due to absorption, to reflex nervous disturbance, or to dislodgment of thrombi is uncertain but it is beyond question that in several cases symptoms of impending collapse, and even death, have followed on washing out an empyema, and that, too, in a patient well on in convalescence. Again, it cannot be too strongly insisted upon that fœtor calls for a freer opening, not for washing out. If, however, it is decided to make use of injections, dilute and bland ones—*e.g.*, Condy's fluid—should be used, and these should be gently run in with a funnel and tubing, and not thrown in with a syringe. A long period of drainage is often needed in adults, while in children the tubes can be quickly shortened. In both sufficient tubing should be retained to keep the opening patent as long as any discharge remains.

During the prolonged after-treatment everything should be done to improve the general health. Change of air is here a cardinal point; first, getting the patient from his room, then outside the house, and lastly, if possible, to the seaside.*

A point of no small importance in the after-treatment, especially in young subjects with flexible spines, is to encourage early, systematic, deep breathing and gymnastic exercises—thus to promote expansion of the chest, and so minimise that sad sequela of empyema, irremediable lateral curvature.

Before leaving the subject of the operative treatment of empyema, a few words should be said about the dressing of these cases. This should be strictly antiseptic from first to last—*i.e.*, cleansing the parts incised, disinfection of instruments, taking care that the pus escapes under an antiseptic atmosphere (p. 691), a sufficiently free opening, adequate drainage, abundant dry antiseptic gauze dressings, changed twice perhaps in the first twenty-four hours, and then daily for the first week. Later on, when the patient is going to the seaside, he can easily be instructed to remove and cleanse daily the short piece of drainage-tube which keeps the external opening patent, and to apply over the sinus a dressing of boracic acid lint and carbolised tow, with a dusting of iodoform, or Jeyes' powder.

Where an empyema exists on each side, the wisest course is to open and drain one, and at the same time to aspirate the other, which should be opened a few days later.

At the wish of Dr. Pye-Smith, in a patient of his, a boy of 9, Mr. Manning, his house-physician, adopted this course, with my assistance, in June 1895, with an excellent result.

Complications of Empyema and Reasons for Cases not doing Well.

(1) Persistent septic condition, in spite of two openings, free drainage, &c. (2) Failure of the lung to expand, owing to dense adhesions, and also, possibly, to fibroid changes in the lung itself. (3) Tubercular disease. (4) Lung mischief on the opposite side—*e.g.*, broncho-pneumonia, bronchitis. This is especially dangerous in patients over

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* "Last, and most important of all—unfortunately for hospital patients a treatment that cannot often be utilised—comes *Margate air*. Any seaside air is beneficial, but, weather and season permitting, I do not believe there is any corner of England so quickly restorative to children with empyema as that in which Margate and Broadstairs are situated; and, personally, I set more store by a change of this kind after the first three or four weeks have passed than in any continuation of antiseptic dressings" (Goodhart, *Dis. of Children*, p. 345).

forty. (5) Caries of the ribs. Multiple spontaneous openings, with burrowing sinuses beneath the skin. (6) Age. From the feebler powers of repair and the more rigid condition of the chest as life advances.

In July 1894 I opened an empyema in a patient aged 60, under the care of Dr. Herbert Burton (of Blackheath) and Dr. Goodhart. A slow but complete recovery followed.

(7) Cardiac dilatation. (8) Inflammation of other serous membranes. (9) Size of the empyema. The smaller and the more localised the collection, the better the prognosis. (10) Collection of pus forming in the opposite pleura. (11) A broken-down constitution. Intemperance; kidney disease. (12) Mr. Godlee (*Dict. of Surg.*, vol. i. p. 459) reminds us that a curious complication of septic cases—viz., cerebral abscess—has been noticed in a sufficient number of instances to make it unwise to overlook the possible association of one with the other. Judging from Dr. Fagge's remarks on thoracic disease as a cause of cerebral abscess (*Prin. and Pract. of Med.*, vol. i. p. 546), it would appear that disease of the lung itself is oftener the primary lesion upon which the abscess of the brain depends.

RESECTION OF RIBS.

Indications.—These are chiefly:

A. Caries of ribs.
B. In certain cases of empyema.
C. For a wound of an intercostal artery.
D. For removal of growths.

Apart from cases of tubercular origin, I have resected parts of the fourth, fifth, and sixth ribs, keeping up persistent mammary sinuses, the caries being here due to old abscess of the breast. In another patient I twice resected ribs in operations for extirpation of recurrent cancer of the left breast. Strict antiseptic precautions can alone justify this, as the sal alembroth dressings were placed in immediate contact with the lung and pericardium. The patient remained without further recurrence two years after the resection of the ribs, and eight after the primary operation. A little later I heard that she had died, under the care of a homœopath—I imagine from another recurrence, or from visceral deposits.

A. In obstinate *caries*, where more than one rib is affected, where previous treatment, including gouging, fails, resection should be at once performed. It is a very simple operation in these cases, as the soft tissues are nearly healthy and the periosteum is retained.

An incision, about two inches long, being made over the centre of the carious rib, and the muscles peeled off with a blunt dissector, the periosteum is next incised, and separated from the upper and under aspect with an elevator, blunt and slightly curved, so as to pass readily under the rib and lever it upwards. The rib being thus raised, it is easily divided at one limit of its exposed part, either with a narrow-bladed saw or with slightly curved cutting-forceps. The soft parts are next peeled away from the under aspect, and the rib divided at the corresponding spot and removed.

B. In certain cases of *empyema*—*e.g.*, (1) when the drainage is insufficient, the discharge foul, in spite of one or two free openings; (2) when the ribs are too close together for a tube of sufficient size;

(3) when an empyema cavity still persists, though sweet, in spite of free incision, good drainage, and careful dressing. In the first two classes of cases removal of a small piece of one or two ribs, as above described, will be sufficient, but in some of these latter cases the operation will necessarily be a much more severe one. When called to a case of persistent sinus and discharge after the incision of an empyema, the surgeon on examination may find that the cavity which remains is small, and that the discharge is due to a persistent sinus only. This should be dilated up with laminaria tents, part of a rib removed, and both sinus and cavity thoroughly scraped out with sharp spoons.

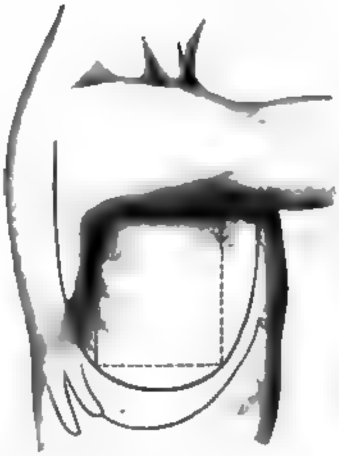
But in the majority of cases of long-standing empyemata the condition of things is not so simple and so easily dealt with. Obliteration has taken place often very imperfectly, owing to the lung not being able to expand, to the ribs having fallen in all they can, to the diaphragm having risen, and the opposite lung, the heart, &c., having come over as far as they are able; while the cavity, often large, which thus remains, is lined with much thickened scar-like tissue, covered with granulations of but poor vitality. Here portions of several ribs must be removed and the operation perhaps repeated, in order that the walls of the cavity may still further collapse, and thus obliterate the cavity while an opportunity is given for exploring this thoroughly.

The spot chosen for the resection of the ribs should be, as far as possible, opposite to the lung which can expand no more, and the pieces of ribs removed should correspond as closely as may be to the anterior and posterior limits of the cavity which it is desired to close. The size of the cavity should be carefully estimated with the aid of sterilised catheters and sounds.

It has been thought by some that the amount of rib to be removed should correspond pretty closely to the distance between the two pleuræ. Thus it may be needful, especially in an adult, to remove pieces of five or six ribs, 3½ inches being removed from some and 1 to 1½ inch from others.

Dr. Fenger, of Chicago (*Med. News*, Nov. 13th, 1882), ascertains first the shape and extent of the cavity. He considers that a cavity which extends transversely requires resection of a large piece of one or of a few ribs, the largest piece taken being that from the rib which overlies the centre of the cavity. A vertical cavity covered by five or six ribs will need resection of small pieces of several ribs, from ⅘ to 2⅛ inches of bone being removed.

Fig. 233.



Schede's incision for thoracoplasty. The curved incision shows the large flap; the dotted one the line along which the ribs are resected.

The ribs to be resected may be exposed in one of two ways. One is to make two or three incisions, and to raise flaps comparatively small in size. The other, which is the method of Schede (Fig. 233), is to raise a single large flap, containing any muscles—*e.g.*, the pectoralis major and serratus magnus—which overlie the ribs to be removed. This latter plan has the high authority of Mr. Godlee, who has done much to introduce this operation into English surgery, and who has had much practical experience at the Brompton Hospital. This operation will be the best where the patient is in good condition, and the surgeon, having had experience, can operate rapidly.

The hæmorrhage, which is free and by no means a light matter in many of these patients, should be effectively controlled by the application of Spencer Wells's forceps and thoroughly applied sponge-pressure. Any that is especially difficult to arrest will cease as soon as the pieces of ribs are removed and the cut intercostal arteries clamped.

In the other case, where several incisions and smaller flaps are made use of, small incisions being made at right angles to the long ones, and flaps of skin and fascia, parallelogram in shape, raised, the muscles are then peeled off each rib with a blunt dissector or slightly curved elevator. Whichever method is employed, care must now be taken to leave the periosteum on the rib (the only safe guide being not to strip off all the muscles), and by no means to detach it. If it be left behind, it will throw out callous material, which will be as unyielding as the bones removed. The elevator is then slipped under the rib, run along, close to its posterior aspect, to one limit of its bared surface, and the rib divided here either with a narrow strong-backed saw—an osteotomy saw or a Fergusson's jaw-saw answers the purpose excellently—or with cutting-forceps. The rib being then raised up when cut, is divided again at a corresponding spot, and as many as is desirable treated in the same way. Each piece of rib should show clean-cut surfaces at either end, and be covered with periosteum. Throughout the operation the surgeon's finger should keep him accurately informed as to the limits of the cavity, especially when he approaches these in dividing the ribs.

Schede removes as much as possible of the thickened pleura which is now exposed, and, with it, any periosteum and intercostal muscles which have been left behind. Some square inches of this may be taken away without fear of serious hæmorrhage, if it be snipped through gradually with curved blunt-pointed scissors, the vessels met with being easily secured as they are divided.

The cavity may now be thoroughly explored with the finger or a soft catheter. If fœtid, or lined with ill-formed lymph, it may be gently scraped out with a sharp spoon, great care being taken when this comes in contact with important parts, such as the pericardium, root of the lung, &c. Iodoform or Jeyes' dusting powder should be blown in, and, where there is much fœtor, the *ends* of the gauze strips with which the cavity is plugged should be wrung out of turpentine. Drainage-tubes are then inserted, if needful, and if a large flap has been raised, this is secured *in situ* with a few points of suture. If, on the other hand, multiple small flaps have been raised, no sutures should be inserted, as primary union cannot take place, and discharges might be pent up.

The wound, at the bottom of which probably lies the lung covered over only with visceral pleura, is lightly filled with strips of antiseptic gauze or boracic acid lint and salicylic wool or carbolised tow retained h a many-tailed bandage. If strict precautions are taken by cleans-
the instruments, irrigating carefully, and keeping the wound

covered with carbolised lint whenever practicable, asepsis will be preserved. All sources of chill and shock should be avoided.

With regard to **the date at which ribs should be partially resected in long-standing cases of empyema,** most surgeons who have seen much of these troublesome cases will, I think, agree that the operation should be performed as soon as the natural powers of obliteration are at a standstill, care being taken that the patient has recovered from the effects of the first operation, and perhaps recruited his strength at the seaside.

Estländer, who first introduced this operation, advises, on the other hand, that the operation should not be made use of too early, as he considers it essential that the two layers of pleura should be changed into thick, firm connective tissue for the operation to succeed. Thus an interval of about six months after the formation of the empyema would seem, according to this view, to be the proper time for resection of ribs; but, on the other hand, too unyielding a condition of the chest walls, too thick a layer of scarred pleura and pyogenic membrane, are conditions not to be waited for.

C. *Wound of Intercostal Artery.*—When hæmorrhage from one of these vessels cannot be otherwise dealt with, removal of a rib will give much readier access to the spot, and a ligature will arrest the bleeding far more satisfactorily than the ingenious devices mentioned in the text-books.

D. *For Removal of Growths.*—An attempt may be justifiably made to remove a growth arising from the ribs if the following conditions are favourable. The growth should be of moderate size, not involving parts of more than four ribs; its history should be a slow one; its outline should be nodulated, well defined, and its surface hard, pointing to a chondroma or osteo-chondroma, the skin over it thinned, perhaps, but not infiltrated. There should be no dulness in the neighbourhood of the growth, the breath sounds should be normal, and there should be no enlargement of the axillary or the inguinal glands. The following is a successful case:

Zarübin, of Kharkov, relates (*Trans. of the Kharkov University Society*, 1891, *Supplement to Brit. Med. Journ.*, Aug. 1, 1891) the case of a young Cossack, who sought his advice for a steadily-growing and occasionally painful tumour of seven years' standing. It measured 21 centimetres horizontally, and 19 vertically, occupying the right side of the chest between the nipple and the post-axillary line from the sixth to the ninth rib. The new growth was hard, nodulated, immovable, and non-adherent to the skin. The integuments over it were thinned but otherwise normal, and the nearest lymphatic glands apparently unaffected. An osteo-chondroma of the thoracic wall was diagnosed. The huge mass was removed, together with the involved portions of the seventh, eighth, and ninth ribs. The gap left in the chest measured 17 centimetres in a horizontal, and 16 in a vertical direction. On opening the thoracic cavity the lung collapsed, but only partially, owing to pleural adhesions around the periphery of the new growths. No serious respiratory or cardiac disturbances occurred, and the hæmorrhage was only trifling. The cavity was gently cleansed with gauze soaked in a 1 per cent. solution of boracic acid, and the skin wound, conical in shape, closed. The growth, much larger than an adult head, weighed over 6 lbs. For the first two days the patient was much collapsed and cyanosed, and suffered from agonising cough and obstinate vomiting. The healing of the wound was complete in two months. The author alludes to ten other cases of resection of the thoracic wall for new growths, of which six recovered, while four died.

The following are cases unsuitable for operation:

Seydel, of Munich, reports (*Centr. f. Chir.*, No. 51, 1890) a case of sarcoma of the ribs in a man, aged 22, which dated from an injury and grew rapidly. At the operation the growth was found to have extended to the liver. It soon recurred *in situ*, and the patient died a little later with secondary deposits in lungs and liver.

Dr. Park, of Buffalo (*Ann. of Surg.*, 1888, p. 254), relates a case in which he removed part of the chest wall for a sarcoma. This was secondary to a small round-cell sarcoma of the leg, for which amputation through the knee-joint had been successfully performed. The growth was about the size of a hen's egg, a little above and to the outer side of the left nipple, fixed. and tender; the skin over it was movable, and no enlarged glands could be made out. There was no dulness on percussion in the neighbourhood of the growth, the chest expansion was normal, and on careful auscultation no difference could be detected in the sounds of the two lungs.

At the operation, by a crucial incision, flaps were turned back, and four ribs—fourth, fifth, sixth, and seventh—were found to be involved, necessitating the removal of part of the chest wall some 5 inches in length by 3½ in width. Numerous sarcomatous nodules were scattered throughout the left lung. Towards the close of the operation the pulse was 140 and very weak, the respirations 30 but regular in rhythm, and there was slight cyanosis of the face. Save for great pain, the patient did well for a few days, but sank at the end of the week. At the necropsy the cavity of the left pleura was found filled with a bloody serum free from odour. The lung was soft and tore easily. Both lungs were studded with sarcomatous nodules.

CHAPTER III.

OPERATIONS ON THE LUNG.

OPERATIVE interference may be required in the following conditions:—(1) Non-tuberculous abscess of the lung; (2) Gangrene of the lung; (3) Hydatid disease; and (4) Bronchiectasis. Operations have also been undertaken in cases of tuberculous disease of the lung. In some instances abscess cavities have been opened and drained; in others the diseased apex of the lung has been removed with the knife or cautery. These procedures have, however, been attended with results so unsatisfactory that they cannot be recommended unless possibly under very exceptional circumstances.

The following statistics, published by Trzebicki in 1892, will give a general idea of the results and prognosis in cases of the above-mentioned diseases:—

1. **Simple Abscess of the Lung**: 42 operations.
   - 14 complete recoveries.
   - 3 recoveries with fistula.
   - 24 deaths.
   - 1 result unknown.
2. **Gangrene of the Lung**: 24 operations.
   - 7 complete recoveries.
   - 1 recovery with fistula.
   - 1 not yet healed.
   - 13 deaths.
   - 2 result unknown.
3. **Hydatid Disease**: 45 operations.
   - 37 complete recoveries.
   - 1 recovery with fistula.
   - 6 deaths.
   - 1 result unknown.
4. **Bronchiectasis**: 12 operations.
   - No complete recoveries.
   - 1 not yet healed.
   - 8 deaths.
   - 3 result unknown.

In considering the above figures the high rate of mortality in these diseases when no operation is performed should be borne in mind. For instance, the mortality from gangrene of the lung when left to itself is

75–80 per cent. (Paget, *Surgery of the Chest*), whereas the mortality calculated from Trzebicki's figures is 54 per cent. Moreover, recent statistics show far better results after operation for gangrene. Réclus gives 14 cases, with 11 cured, 1 improved, and 2 deaths—a mortality, therefore, of only 14 per cent.

Where, from the symptoms and physical signs, a probable diagnosis of localised abscess, bronchiectasis, circumscribed gangrene, or hydatid cyst has been arrived at, puncture with a fine exploring needle is the best means of ascertaining whether further surgical procedure is justifiable. This, however, should not be undertaken unless preparations for immediate operation have been made; and this applies particularly where hydatid cyst is suspected, for in these cases leakage of hydatid fluid has been known to set up violent inflammation both of the lung and pleura.

By means of puncture in one or more places, not only may the pus or fluid be found, and the cavity thus localised, but valuable information with regard to the presence of adhesions between the lung and the pleura may be obtained; for if the needle does not oscillate synchronously with the movements of respiration, adhesions are certainly present. On the other hand, the exploring needle will fail where the cavity is deeply placed, and also when the cavity is empty owing to recent expectoration of its contents, or again, where the cavity only contains thick pus. Moreover, Mr. Godlee's words (*Lancet*, 1887, vol. i. p. 459) on this point should be remembered; he says, "It is impossible to penetrate the lung with any amount of accuracy or definiteness, because it recedes before even the sharp point of a needle."

Operation.—The anæsthetic should be given slowly to avoid coughing, and the patient kept on his back as much as possible—these two precautions being intended to prevent fluid, coughed out of the cavity, dangerously obstructing the bronchi. Chloroform or the A.C.E. mixture should be the anæsthetic chosen in these cases, in order to avoid the coughing and congestion produced by ether.

Taking the needle-puncture as a guide, an incision three inches long is then made over the middle of the rib nearest to the puncture. This incision goes down directly on to the bone. The periosteum is now divided over the exposed area of rib, and separated from the bone by means of a slightly curved raspatory, care being taken to thoroughly detach the periosteum from the deep aspect of the rib. The portion of rib thus exposed is now divided in front and behind with cutting-forceps or saw, and removed. The pleura is now carefully exposed by incision of the periosteum, and the question of the presence or absence of adhesions determined. If no thickening of the pleura is found, and the lung can be seen freely moving beneath it, means must be taken to shut off the pleural cavity before the lung cavity is opened. Absence of adhesions, however, will only be found in acute conditions, and even then quite rarely. The best treatment under such circumstances is to suture the lung and pleura together over a small oval area, and wait forty-eight hours before completing the operation. This is most satisfactorily and easily accomplished by the method of Roux, which I give in his own words as translated by Paget: "Having incised the intercostal muscles, exposed the pleura, and seen the lung moving freely beneath it, I sutured the two layers of pleura together all round the wound, catching up the lung tissue with a curved needle as, during each inspiration, it came forward into the wound. But instead of simply putting separate points of suture here and there, and thus leaving gaps which might admit air, I did what the women in my part of the country call 'suture à arrière-point': the needle is passed through the pleura, picks up the lung, and comes out again through the pleura; then it is put through again between the points of entrance and exit, picks up the lung again, comes out in front of the first point of exit, and so on; thus you can get a continuous suture all round, and finish by tying the two ends together. It keeps the two layers of pleura in perfect apposition, and yet there is no dragging on it; so that you avoid the little lacerations and gaps that you get with an interrupted suture."

The next step in the operation consists in opening the cavity in the lung. This is best done with a medium-sized trocar and cannula, the opening so made being dilated with dressing-forceps. The finger is then gently inserted to ascertain whether any dead cast-off lung tissue, or, in the case of an abscess, a foreign body, is present.

A full-sized drainage-tube (soft, for fear of hæmorrhage from friction and ulceration) should be inserted, and sufficient antiseptic dressings (iodoform or sal alembroth gauze with salicylic wool) applied.

Hæmorrhage is not commonly met with after puncturing the lung, as this is probably solidified and altered round the abscess cavity. If it be severe, the cavity must be plugged with aseptic gauze wrung out of turpentine. When any rotten lung-tissue has been removed with the finger, hæmorrhage is to be expected.

If the cavity be due to an hydatid, the cyst wall may perhaps be expelled when coughing is set up by the incision of the cavity. If it does not so come away, it should be removed, if this can be effected without setting up hæmorrhage. A good instance of how large cavities in the lungs may be, when due to this cause, is given by a case of Dr. Fenger's (*Lond. Med. Record*, 1881, p. 327), in which he successfully operated by an incision in the third space (through adherent pleura), for a gangrenous hydatid cavity in the right lung, reaching from the second to the fifth rib, and from the sternum to the posterior axillary line.

After-treatment.—The cavity should be syringed out with a 1 in 50 solution of carbolic acid till fœtor disappears, and then with thymol lotion. If fœtor is obstinate, gentle plugging with gauze wrung out of turpentine should be tried. The drainage-tube must be retained until the cavity has almost completely closed—*i.e.*, until the discharge has almost, and the expectoration has quite, stopped. If the tube be removed too early, refilling of the cavity, with return of fever, nausea, expectoration, &c., is certain. Moreover, as the external opening tends to close before the cavity is obliterated, any foul remaining matter which does not escape may be drawn into the bronchi and set up diffuse bronchitis and broncho-pneumonia.

The general health must be sustained, and every attempt made to secure fresh air, whether in the patient's room, or by getting him as soon as possible into another room, and out of doors.

Even if the operation does not save life, it may make the remainder much more comfortable both to the patient and his friends.

Dangers and Difficulties in Opening a Lung Cavity.

1. Dyspnœa, coughing, and choking expectoration with the anæsthetic (p. 700).
2. Pleural adhesions absent (p. 700), or so soft that they easily break down, the lung thus being pushed away from the ribs (Godlee).
3. Missing the cavity and damaging healthy lung-tissue. This is best avoided by careful preliminary use of an aseptic fine trocar or large morphia-needle.
4. Getting, as a result of the operation, diffuse broncho-pneumonia, pleurisy, or pleuro-pneumonia, in the lung operated on or its fellow.
5. Severe hæmorrhage, causing much trouble, owing to the hæmoptysis with the anæsthetic (Godlee), and later on setting up septic inflammation of the lung.
6. Finding a large branching cavity, with numerous caverns, difficult or impossible to drain.
7. If the bronchi are dilated and contain fluid similar to a cavity, this may be drawn from a bronchus by preliminary puncture. This is then mistaken for a cavity, and cut down upon.
8. A cavity near the large vessels at the root of the lung.
9. Much consolidation of the lung tissue over the cavity.
10. As a result of the operative interference, secondary rapid sloughing and gangrene of the lung may follow.

This seems to have happened in an interesting case reported by Dr. J. Smith, of Halifax (*Lancet*, 1880, vol. ii. p. 86). Decided relief and improvement followed on the opening of what was apparently a large cavity, but death took place in about a fortnight. The conclusions with which Mr. Godlee (*Lancet*, 1887, vol. i. p. 718) sums up his most valuable lectures on this obscure and difficult subject may be quoted here :—

> "1. Gangrenous cavities should always be sought, and, if possible, opened; and the prognosis, if the operation be successful, is not bad. 2. The same may be said in regard to abscesses caused by the rupture of purulent collections from other parts into the lung, at least as regards the pulmonary complication. 3. Abscesses connected with foreign bodies must be opened, and, if the body be not found, it must be remembered that, if of any considerable size, it probably lies pretty near the middle line. If possible, these cases should be treated early by tracheotomy and incision. 4. Bronchiectatic cavities, when single (a very rare condition), will be cured by operation. When multiple (a very common condition) they offer but small chance of relief by our present surgical methods. Still, for the reasons stated, an attempt may be made to open the main one, if such is to be found, but only if the pleura has been ascertained to be adherent. 5. Tubercular cavities should only be opened in cases where the cough is harassing, and the cavity single. Injections may be used to relieve symptoms, but cannot be expected to be curative."

CHAPTER IV.

TAPPING OR INCISING THE PERICARDIUM. SUTURE OF WOUNDS OF THE HEART.

TAPPING OR INCISING THE PERICARDIUM.

Indications.

1. When a pericardial effusion has resisted previous treatment, and signs of cardiac distress are increasing.
2. When there is a steady increase of præcordial dulness.
3. When the heart-beat and pulse are becoming feeble.
4. When cyanosis, dyspnœa, and epigastric distress are present.
5. When the effusion persists, when it is accompanied by œdema, rigors, and pyæmia, when it occurs in a much weakened patient as part of pyæmia, the fluid is probably purulent.*

The most suitable place for puncture is, in ordinary cases, the fifth left intercostal space, about one inch from the edge of the sternum, so as to avoid both the internal mammary artery and the pleura, the instrument being a trocar and cannula, with or without aspiration according to the facility with which the fluid flows. A pint of serum, and in many cases over a pint, has been removed. The withdrawal of a much smaller amount—viz.,three or five ounces—has been followed by recovery.†

Dr. Goodhart points out to me that the position of election is still an open question, each case calling for a decision by itself. In Dr. West's collection of cases (*loc. supra cit.*) the following sites of puncture are mentioned:—In thirty, the fifth space; in twenty, the fourth; in three, the sixth; in three, the third; in one, the seventh; in one, the eighth; and in three, the third or fifth *right* space. Apart, however, from exceptional cases, the site usually chosen is the fourth or fifth left space, one inch from the sternum; thus both the pleura and the internal mammary artery are avoided.

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* In Dr. West's case (*Med.-Chir. Trans.*, vol. lxvi. p. 266), treated successfully, first by tapping and then by free incision, there were no rigors or sweating, but œdema of the chest walls, most marked over the præcordial region, was present. So, too, in a patient of Prof. Rosenstein's, a boy aged 10, with a large purulent pericardial effusion, the temperature was hardly above normal, and there was no œdema.

† With regard to the amount to be withdrawn, Dr. Stewart (*Edin. Med. Journ.*, Aug. 1885) thinks that, if serous fluid is found, aspiration should be made use of, but only enough withdrawn to give relief. He points out that it is a sound rule, in dealing with vital organs, that only a minimum amount of interference should be had recourse to, and that this is especially necessary in cases which threaten pulse-failure. The tapping should be repeated rather than too much fluid be drawn off at once.

A preliminary puncture having been made with a scalpel, the trocar—in the case of serum, a hydrocele trocar will probably be sufficient—scrupulously clean, should be steadily pushed, with antiseptic precautions, for 1¾ or 2 inches through the chest wall, and at a right angle to it. The trocar should then be removed, and, if fluid does not flow, the point will probably be found not to move freely in a cavity. It should then be pushed cautiously onwards, and its point at once sheathed if it is felt to touch against a soft obstacle.

On the fluid ceasing to flow, the puncture should be closed with collodion and iodoform.

Dr. West thinks (*loc. supra cit.*) that paracentesis pericardii may be performed with advantage, not only in the pericardial effusions of rheumatic or primary origin, but also in those which occur in the later stages of general dropsy, if it should appear that the fluid in the pericardium is adding to the difficulties under which the heart is placed. According to the cases which he has collected, with one exception,* all the patients were much relieved by the removal of even a small amount of fluid, and many recovered completely who would probably have died if the operation had not been performed.

The co-existence of effusion into the pleuræ and peritoneal cavity in many of these cases must be remembered.

If pus is present the case must be treated by free incision. An anæsthetic having been given,† the trocar is taken as a guiding director, and a narrow, sharp-pointed bistoury carefully thrust in by its side; the opening is then further dilated with dressing-forceps or a blunt-pointed bistoury, care being taken to keep the internal opening into the pericardial sac free. A soft drainage-tube should next be inserted, and, when all the pus‡ that will come away has escaped, antiseptic gauze dressings should be applied.

As, however, the proximity of the costal cartilages to one another will only allow of the introduction of a small-sized drainage-tube, it is wiser to resect one inch of the fifth costal cartilage. This, while only very slightly increasing the length of time occupied by the operation, will allow of the insertion of a large drainage-tube, and thus free and efficient drainage will be ensured.

During the first few days after the operation the drainage of the cavity may be materially assisted by keeping the patient on his face as much as possible.

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* In this case, No. 51 in Dr. West's list, death took place, five minutes after the puncture, from hæmorrhage into the pericardium following injury to the right ventricle. But in another case, No. 29, the patient died two hours after the operation, the left pleura being found to contain air and blood, the latter coming from a puncture in the heart.

† Chloroform will perhaps be the wisest, especially if pleural effusion co-exists, on account of the greater struggling with ether. Punctures for cocaine injection will be painful, and very likely futile.

‡ In Dr. West's case, a boy aged 16, this was estimated at two quarts. If the pus is foul, but not otherwise, the cavity should be syringed out with dilute carbolic acid or mercury perchloride solution.

Causes of Failure.

1. The heart fatty or dilated. These changes may come on very rapidly.
2. Pyæmia and septicæmia.
3. Co-existing effusions into pleuræ and peritoneal cavity.
4. Œdema of lung. Evidence of this should be most carefully watched for. This proved fatal in the case of a patient of Dr. Goodhart's, a young lady of 14, from whose pericardium I removed forty-six ounces of pus by an incision in the fifth right space, a little outside the sternum.
5. Co-existing diseases—*e.g.*, phthisis, or renal disease.

SUTURE OF WOUNDS OF THE HEART.

Apart from the recoveries that have taken place after suture, severe wounds of the heart have been almost invariably fatal. Surgical intervention has, however, undoubtedly saved a considerable number of lives, as may be gathered from the following figures:—Loison (*Revue de Chirurgie*, 1899, Nos. 1, 2, 6) collected 90 cases of wounds of the heart by cutting instruments. Of 72 cases not operated upon, 71 died; of 18 cases treated by operation, 10 recovered. Again, Hill (*New York Med. Record*, Dec. 15, 1900) gives 17 cases of heart suture, 7 of which, or a percentage of 41, recovered.

Wounds of the heart may be either penetrating or non-penetrating—the great majority of them belonging to the former class. The ventricles are more often injured than the auricles, and the right ventricle more commonly than the left. It has been shown, both by experiments upon animals and by the operations that have been performed on man, that interrupted silk sutures, passed deeply into the myocardium, produce perfect hæmostasis. The sutures should be passed—as recommended by Rehn, quoted by Ware (*Annals of Surgery*, Oct. 1899)—during diastole, since the heart sinks back during systole into the pericardial space.

Various methods have been employed in exposing the heart and pericardium, the plan usually adopted being to turn back a flap containing skin, muscles, and ribs, or even a part of the sternum. Ninni, quoted by Ware (*loc. supra cit.*), made use of the following method in a nearly successful case, and recommends it as the result of studies on the dead subject:—Incisions are made along the left side of the sternum from the third to the sixth rib, and for the same length in the mammary line; joining these, a horizontal incision is made in the fifth interspace. The third, fourth, and fifth ribs are divided along the lines of the incisions, and a flap containing skin, muscles, and bone turned upwards.

The following account of a successful case by Parrozzani, as given by Hill (*loc. supra cit.*), will sufficiently illustrate the steps of the operation:

> "Parrozzani, in 1897, operated upon a young man who had been cut three times. Two of the cuts were of no importance. He followed his assailant thirty steps, and fell. Five hours after the injury he was carried to the hospital, where it was found that the dagger had entered the seventh left intercostal space in the mid-axillary line. His general condition was extremely grave, heart-beats and pulse almost imperceptible,

and respiration rapid and superficial. Immediate intervention without an anæsthetic was decided upon. An incision through the soft parts, an inch and a quarter from the margin of the sternum, in the fourth intercostal space, was carried for a distance of five inches and a half, then it descended vertically in the mid-axillary line as far as the superior margin of the ninth rib. The fifth, sixth, seventh, and eighth ribs were cut through in the mid-axillary line with the pleura. The musculo osseous flap or door was raised, with the cartilages of the ribs acting as the hinges. The pleural cavity was filled with blood, and an opening one inch in length was found in the pericardium, which was subsequently enlarged to two inches and a half. There was very little blood in the pericardium, because the injury was in the most dependent part, and the blood readily escaped into the pleural cavity. A wound in the apex was observed, three-quarters of an inch in length, through which the little finger was passed into the left ventricle. This served the double purpose of checking the hæmorrhage and steadying the organ for the introduction of the sutures. Four deep silk stitches were used, not touching the endocardium. Passing the needle caused violent throbbing of the heart. The pleura and pericardium were thoroughly cleansed, and the flap was sutured in position. Stimulating hypodermic injections were used, and hypodermoclysis and auto-transfusion practised. The operation lasted one hour and a quarter. Recovery resulted."

In the majority of the cases the wound was situated in front, and the pericardium was usually found to be distended with blood. The length of time between the injury and the operation has varied considerably : in a successful case by Rehn it was more than twenty-four hours ; in a case of Giordano's, in which the left auricle was sutured, the operation was performed within half an hour of the receipt of the injury. In the majority of the cases some hours elapsed before the operation.

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Pardon & Sons, Printers, Wine Office Court, Fleet Street, London, E.C.

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